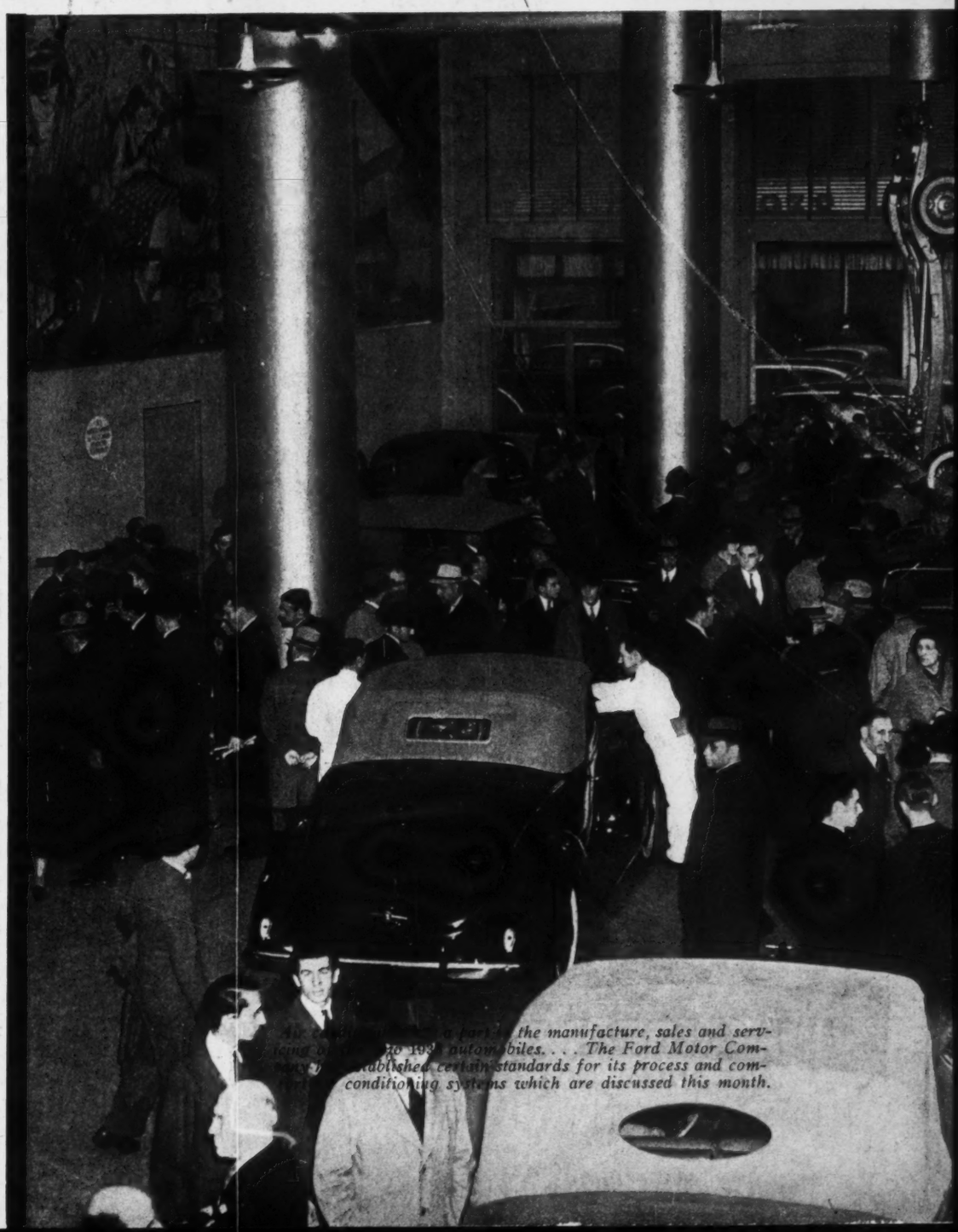
DEC 6 1937

Heating · Piping and Air Conditioning



... the manufacture, sales and service ... automobiles. . . . The Ford Motor Company ... established certain standards for its process and comfort conditioning systems which are discussed this month.

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The Editor's Page

■ **The consulting air conditioning engineer's** services are listed in an attractive booklet issued by Kribs & Landauer, air conditioning engineers, Dallas, Texas, as follows:

1. Survey of the building; the occupancy, business done, possible increase in number of employees and customers. Value of floor space, present lighting load, study of architecture to determine how units and ducts can best be placed, anticipation of future growth. Selection of the type system which must be tailor made to the requirements of the building. If not available, building plans are drawn.
2. Calculations of heat load of building are made together with a detailed check on refrigeration requirements. All ventilation requirements are surveyed for adequate removal of smoke and odor.
3. Complete plan of proposed installation is drawn.
4. Specifications are worked out in detail, giving capacities, style and type of machines, weight of metal used in pipes and ducts, method of duct support, position of units, redecoration necessary.
5. An outline of all legal phases in connection with the installation is made. This includes statements of how contractor and sub-contractors will conduct work, all protective measures necessary, including bonds and insurance.
6. All plans and specifications are presented to the owner of the building for approval. They are then submitted to five or more firms who are capable of furnishing satisfactory equipment for the installation.
7. Proposals are received, checked and the contract is let.
8. The engineers supervise the installation. They are available to owner or contractor at any time.
9. When the installation is completed by the contractor, the engineer checks every unit of the entire project from point of equipment and operation, and if found satisfactory, turns the job over to the owner.
10. Kribs & Landauer are always available for counsel and advise on the continued operation of the system and on any changes that might be requested at a later date.

The booklet points out that air conditioning is a *specialized* field and that in considering an installation, the prospective owner will do well to consult engineers who, in an independent capacity have made a study of all air conditioning problems.

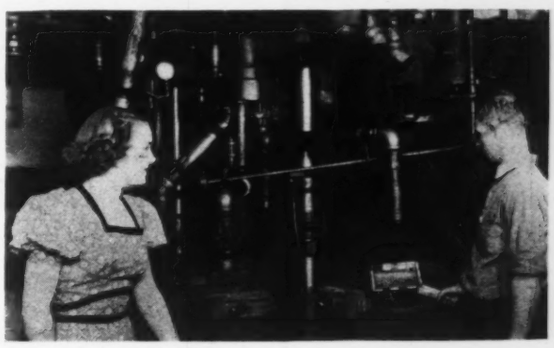
■ **Third quarter installations** by members of the Air Conditioning Manufacturers Association topped the same period of 1936 by 16.5 per cent, installed cost of equipment sold by them totalling $13,239,425, according to William B. Henderson, executive vice-president of the association. Installed cost of equipment sold by them in September was $2,460,855 as compared to $2,796,016 a year ago, a decrease of about 12 per cent. . . . For the first nine months of this year as compared with the first nine months of last year, the association members' total business is far ahead, the installed cost being $74,036,822 compared to $38,947,104, an increase of about 90 per cent.

■ **Best current market** for air conditioning by a wide margin is in the commercial field, according to Roderick P. Stewart, business editor of Barron's. A survey reported by him shows that in 31 large cities the horsepower of installations for this year will be divided about 71 per cent commercial, 12 per cent governmental, 9 per cent industrial, and 8 per cent residential. Central plants are favored to serve groups of offices, while units to serve single offices or suites have been rapidly taking hold, he states. . . . In terms of rate of increase over the previous year, the picture shapes up somewhat differently, showing industrial air conditioning installations forging ahead. . . . Horsepower of industrial installations in 37 large cities is expected this year to exceed last by 76 per cent, with residential installations up 67 per cent and commercial up 60 per cent. Governmental installations slightly exceed industrial and residential in terms of horsepower this year, and show a large percentage increase.

■ **Air conditioning** must be mentioned as an industry "just getting a good start" with demand for motors for compressors and fans already running high with tremendous possibilities for the future, stated R. W. Owens, manager of the motor division of Westinghouse, in explaining some of the business reasons that culminated in the company's new mass production a-c motor aisle at East Pittsburgh. The new aisle incorporates many modern features and is based on the principle that the best handling of any product is generally conceded to be the least handling of it (to use the words of Superintendent G. S. Ryan).

■ **All existing sales** records for mechanical stokers were shattered in September when a total of 19,193 factory sales for that month were reported to the U. S. Bureau of the Census by 108 establishments, according to the Committee of Ten. This represented an increase of 42½ per cent over the previous month and 15 per cent over September, 1936. . . . Ventilating and heating equipment and supplies valued at $4,797,069 were among the nearly one-half billion dollars worth of materials, supplies and equipment purchased for projects of the Works Progress Administration in the first 26 months of its operation up until September 1, 1937, according to records of the WPA division of research, statistics and records.

■ **The smoke nuisance** in large cities is a contributing factor in the spread of disease from air borne bacteria held in suspension on smoke or dust particles, said H. C. Murphy in an address on air pollution and its relation to community health before the Hudson County (N. J.) Smoke Abatement Association last month. . . . Describing recent research at the Harvard School of Public Health indicating that germ-carrying droplets ejected when people cough, sneeze or talk remain in suspension for days, Mr. Murphy said that the latest study of air borne bacteria was leading scientists to think that certain respiratory disease germs were becoming adapted to air transmission.



A picture tour of modern glass manufacturing processes is given by a series of Owens-Illinois Glass Co. photographs titled "Alice in the Wonderland of Glass." The reproduction shows "Alice" witnessing part of the process of making a glass block to be used in building construction.

Grumman Air Craft Engineering Co., Bethpage, L. I.

HEATS MODERN PLANT and HANGAR

with

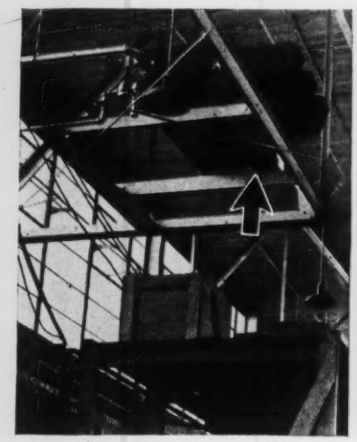
Carrier Unit Heating

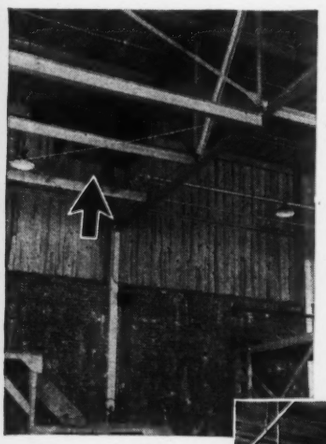
Engineers Consider Installation Excellent Example of Modern Industrial Heating

1. BIG PLANT? Right! It's 400 feet long, 150 feet wide—and the ceiling height is indicated in the illustration. But heating is a simple problem. Because of their remarkable efficiency, only 6 Carrier Heat Diffusers—served by one steam line—are required to heat the entire area.

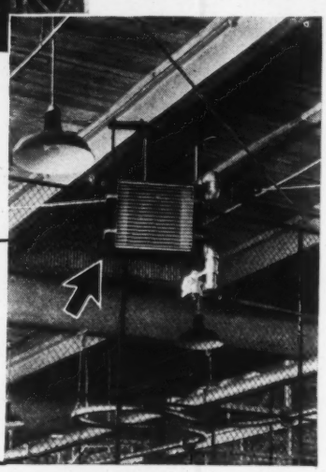
2. CLOSE UP! (left, below). This is the type of Carrier Heat Diffuser used in the Grumman plant. Notice particularly the simple installation, and manner in which the outlets are designed to direct heated air *downwards*, into the working zone. That means economy—reduced heat rise.

3. IN THE HANGAR, (right, below), additional Carrier Heat Diffusers are used. And here again, although the area is approximately 300,000 cu. ft., only 2 units are required to keep the temperature at the proper degree. Compare that efficiency with old-fashioned heating!





4. OTHER SPACES, such as inspection rooms and testing rooms, are heated with Carrier Unit Heaters, Kroy type. Employing the same principles as the large Carrier Heat Diffusers, these units provide the same heating efficiency for smaller areas. Note attractive appearance—black finish and contrasting trim.



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Once you install Carrier Unit Heating, your heating problem is ended for years to come . . . for Carrier Unit Heaters are built to endure. The coils, guaranteed to withstand working pressures of 200 lbs. per square inch, are non-ferrous — and constructed with the famous Carrier return bend principle which eliminates strains due to expansion and contraction, makes leakage virtually impossible. New, specially-designed fans cut power requirements as much as 50%—and are so carefully balanced that noise and vibration are negligible.

Get the facts about Carrier Unit Heating — it may cut your fuel bill 25% or more

Heating · Piping and Air Conditioning

with which is merged the "Aerologist"

Design, Installation
Operation, Maintenance
in Industry and Large Buildings

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CONTENTS *for* DECEMBER, 1937

Volume 9 Number 12

World's Biggest Building Installs New Heating and Combustion Control, by W. A. Stahl 721

New Data for Refrigeration Piping Design—Ammonia Liquid Line Piping, by R. C. Doremus 725

How Should These Offices Be Air Conditioned? 728

Ford Motor Company Sets High Air Conditioning Standards, by J. J. Floreth 729

E. Vernon Hill's Personal Comments 733

Valves—a Review of Available Types and Their Features, by F. H. Morehead 734

Simple Way to Analyze Performance of Compressor-Evaporator Combinations, by William Goodman 737

Show Window Ventilation, by Lester T. Avery 741

Index to Volume 9, Nos. 1-12, January-December, 1937 781

Equipment Developments (back section) 120

Book Reviews (back section) 136

Conventions and Expositions (back section) 138

Recent Trade Literature (back section) 138

Index to Advertisers (back section) 144

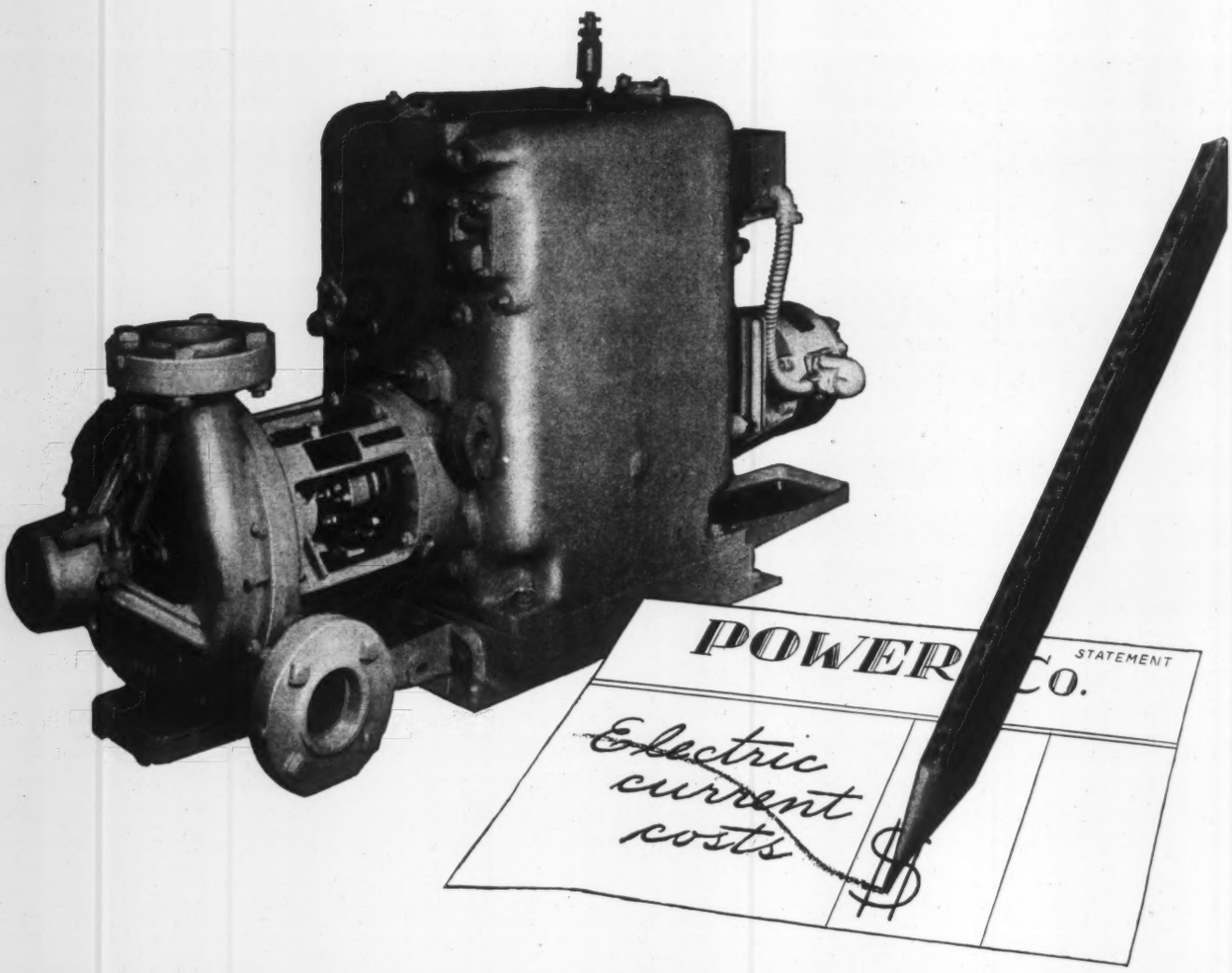
Journal Section of the American Society of Heating and Ventilating Engineers

Study of Methods of Control and Types of Registers as Affecting Temperature Variations in the Research Residence, by A. P. Kratz and S. Konzo 745

Summer Cooling Requirements of 275 Workers in an Air Conditioned Office, by A. B. Newton, F. C. Houghten, Carl Gutberlet and R. W. Qualley 758

A. S. H. V. E. Research—A Page of News Notes and Comment, by Brewster S. Beach 767

Bulletin Section 768



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The really important saving promoted by the Jennings Vapor Turbine is in the system itself, however, for this is the only heating pump that can operate continuously with economy. Continuous operation means uniform circulation, and uniform circulation means a big saving in steam.

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THE NASH ENGINEERING COMPANY

SOUTH NORWALK, CONNECTICUT

Heating · Piping and Air Conditioning

Vol. 9. No. 12. • *December, 1937*

World's Biggest Building Installs New Heating and Combustion Control

Contract Provides for Payments Out of Fuel Savings

MANY advances in the field of heating control have been made since the Merchandise Mart, Chicago—the "world's biggest building"—was completed in 1930. While the Mart's heating system was up-to-date then, there were no provisions for zone control of the building or combustion control in the boiler room, and but a minimum number of boiler room instruments were installed. In line with its policy of keeping the structure up-to-date in every way, the management has recently made a thorough investigation of various control methods, and has invested in modern equipment for securing economy in heating.

About 45 per cent of the heating load in the Mart is created by the wall radiation that takes care of the direct heat losses of the building; the balance of the load is due to the 168 ventilating fans furnishing 1,750,000 cfm of air. There is a small process steam load created by several restaurants and also by manufacturers in the building, but this load is not important as it is very small compared with the total.

The following figures will give an idea of the size of this building. Each of the 18 main floors has an area of 200,000 sq ft. In addition, the National Broadcasting Co. occupies 20,000 sq ft on the 19th and 20th floors, above which there is a tower extending to the 24th floor, making a grand total area of 4,000,000 sq ft. More than 25,000 people (the population of a small city) are employed in the building and the daily traffic averages 50,000 people. During market periods 100,000 people often visit the building in the course of a business day. Nearly 20,000 tons of coal annually, delivered in full size cars on tracks under the structure, are required to heat this huge building.

The first step to modernize the heating control and boiler room instruments for the building was taken when the 1937 budget provided an item for steam flow meters —no flow meters having been included with the original installation. It was decided that flow meters themselves would not result in any great saving, but that a complete system of combustion control equipment and instruments should be installed. In order to effect the greatest possible efficiency in the generation of steam, it was decided CO_2 recording instruments were necessary. Also, draft gages and undergrate dampers and variable drives for controlling speed of the chain grate stokers were recommended.

When considering means to economize in the *making* of steam, it was natural that we also study the conservation of steam used throughout the building, with the final result that it was decided also to include zone control for all of the direct radiation.

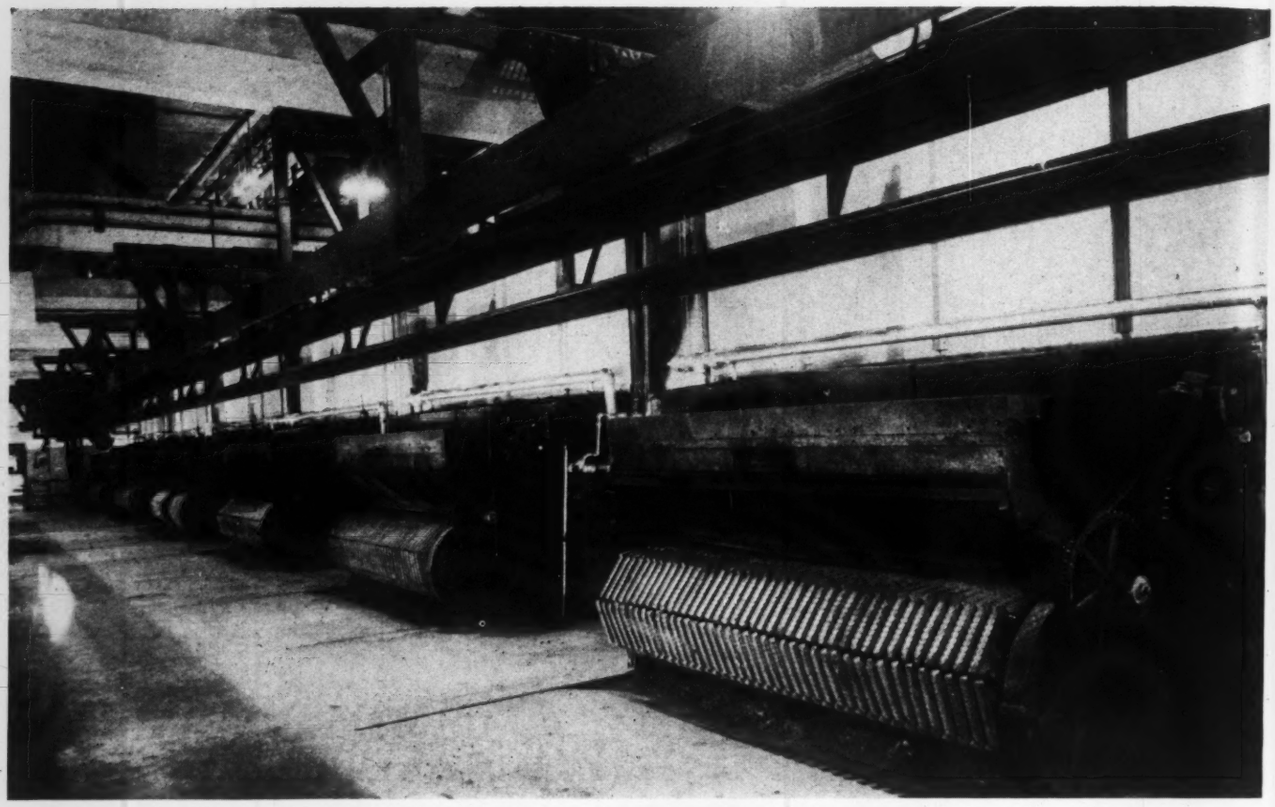
Payments Based on Fuel Savings

Such an installation in a building containing 4,000,000 sq ft of floor space meant a cost in excess of $40,000. Naturally, it was difficult to sell the management on the idea of such a large expenditure in order to save a questionable amount of fuel and to obtain desirable temperature regulation throughout the building. In order to proceed, a plan was therefore worked out to install the

By W. A. Stahl*

*Operating Engineer, Real Estate Div., Marshall Field & Co.

In accord with the management's policy of keeping the Merchandise Mart, Chicago building, up-to-date, the installation of an extensive heating control system and boiler combustion control equipment has just been undertaken. Indicated fuel savings during a two month period are over 20 per cent. . . . The contract for the installation of the control equipment is unusual in that it provides for payments to be based on the actual savings effected each month. Provisions are included in the contract to allow for changes in fuel consumption because of occupancy and other factors



Seven stoker-fired boilers totalling over 3000 hp at normal rating heat the Mart

equipment on a cash payment which would not exceed the original amount appropriated for flow meters this year, together with a similar cash payment for 1938. All of the balance of the cost of equipment was to be charged for out of actual coal savings. Some difficulties had to be overcome in the specifications of this contract, due to the fact that the company installing the equipment was not controlling the process load or the indirect radiation, and also due to the fact that the Merchandise Mart is installing air conditioning, which affects the fuel requirements.

The savings contract is based upon the coal consumption during the heating seasons of 1934, 1935 and 1936. The total average coal consumption for these years was 17,919 tons. The process load for the building was estimated at 3000 tons, making the yearly average coal consumption for heating 14,919 tons. The average seasonal degree day figure for these three years is 6413, making the average coal consumption for heating in tons per degree day 2.326.

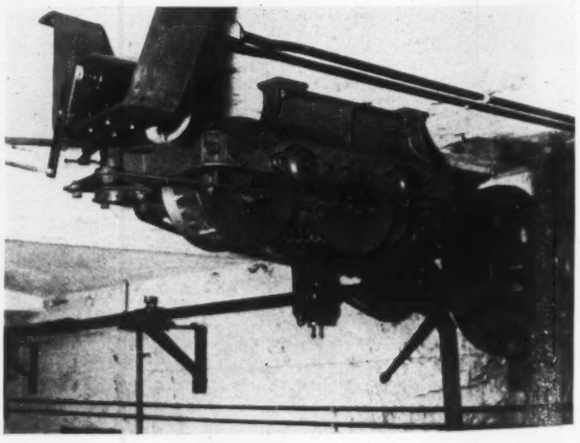
Due to the fact that the occupancy of the building will vary during the time that contract payments will be made, it was necessary to work out correction factors for occupancy. These factors were approximated as follows:

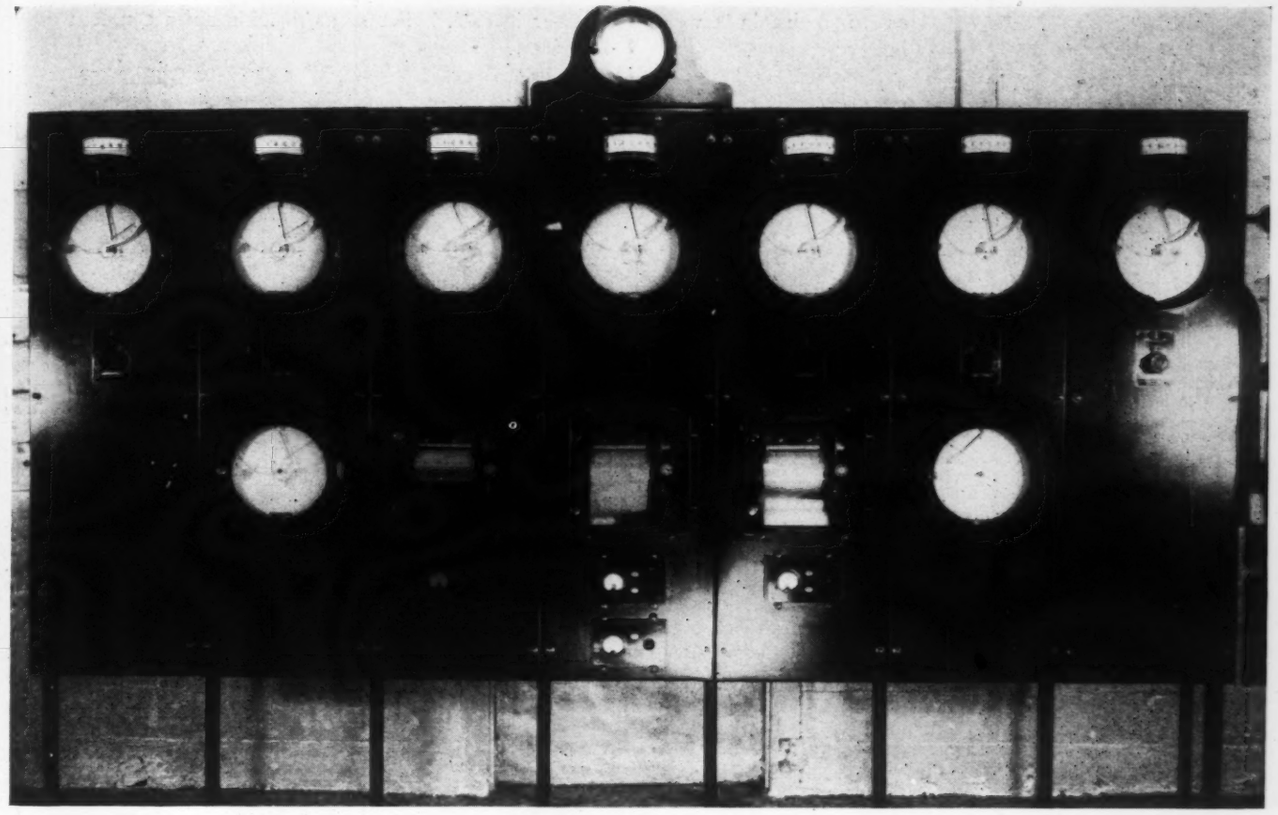
Average Monthly Occupancy Per Cent	Correction Factor
60- 64	0.913
65- 69	0.942
70- 74	0.971
75- 79	1.000
80- 84	1.029
85- 89	1.058
90- 94	1.087
95-100	1.116

In making payments the average past coal consumption in tons per degree day will be multiplied by the degree days for the current monthly billing period. To this will be added 250 tons of coal each month for the heating of process steam. The total tonnage obtained will be multiplied by the average unit cost during the 1934-1936 heating seasons and from this amount will be subtracted the cost for the current month based upon the same average unit cost per ton of coal, in order to obtain the savings effected.

The contract is based upon the use of the present

This variable speed control keeps the coal feed in step with the building load



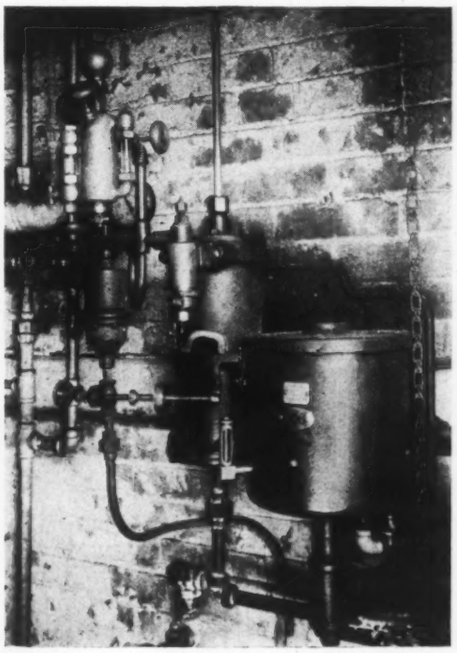


The main control panel is in the center of the boiler room so as to be readily accessible to all firemen and engineers on watch. The Mart has recently arranged to pay the major part of the tuition for a course in combustion control for all of its watch engineers

grade of fuel and the analysis of the coal is stated in the contract.

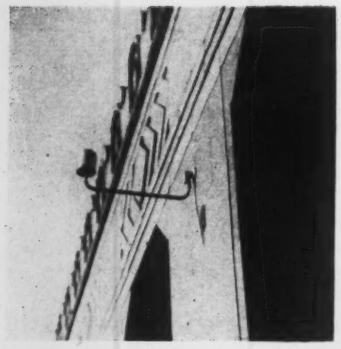
The contract for zone control and boiler room equipment was signed in June of this year, and installation started about two months later. The installation, now completed, includes an eight zone heating control system. In the boiler room there are seven steam flow meters, seven four point draft gages, seven CO_2 and stack temperature recorders, under-grate dampers on seven boilers, seven boiler horsepower indicators, and variable transmission drives for the operation of chain grates. Recording and indicating instruments are all mounted on a panel approximately 10 ft by 20 ft in the boiler room.

Control for uptake damper



Eight Control Zones

There are seven natural divisions of the building created by the fire walls. Each of these seven sections is served from a single riser, with a separate riser for the tower section. An outside thermostat is installed for each of these sections, each connected to high pressure two-position valves on the 19th floor and to a control panel in the boiler room. Each zone control valve may be controlled by manually operated switches from the panel in the boiler room. A three-position switch at the control panel allows the zone valves to be closed, opened, or put under automatic control of the outside thermostat. In addition to the manual switches, there are also switches in the control panel for placing the system in a night shutdown position or in position for normal day operation. The panel also contains indicating lamps for all valves, which show when the valves are opened or closed. A mechanism is provided so that all zone valves will not operate simultaneously, thus calling for an excessive amount of steam, but will follow in sequence so



One of the outside thermostats. A 5 in. cylindrical housing 7 in. high actuates each of the eight valves which in turn supply steam for heating the 50,000,000 cu ft volume of the Mart

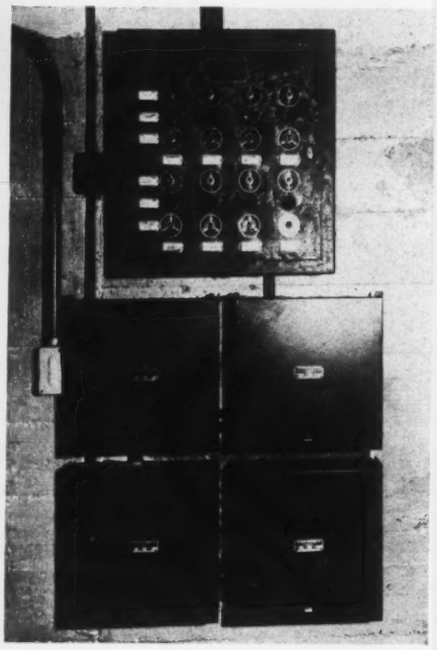
as to maintain even boiler pressure.

About 100,000 sq ft on the ground floor of the Merchandise Mart is given over to a trucking concourse, radiation for which is also fed from the main downfeed risers. Due to the fact that the large doors on this trucking concourse often remain open for long periods of time, and also because of the stack effect created by the 14 freight elevator shafts in this area, it was necessary to install auxiliary unit heaters above the main doors. These unit heaters are fed with steam by the risers to the fan rooms.

Inasmuch as direct radiation in the trucking concourse is now controlled by the main zone valves which are under the new control system it was felt necessary that these auxiliary unit heaters be installed so that temperatures in this area would not fall too low during severe weather.

Stoker operation is controlled by a modulating steam pressure controller which in turn controls a potentiometer type step controller. This controller operates seven modulating type motors which are connected to the variable speed drives and vary the speed of operation of the chain grates. Over-fire pressure is controlled by separate balance draft controls which modulate the breeching damper in each boiler so as to maintain a constant over-fire draft.

A steam pressure controller operates the main uptake damper, and positions this damper in accordance with steam pressure limits. Hand controlled under-grate dampers have been installed in each stoker in order to control the length of the fire and hold down the amount of excess air.

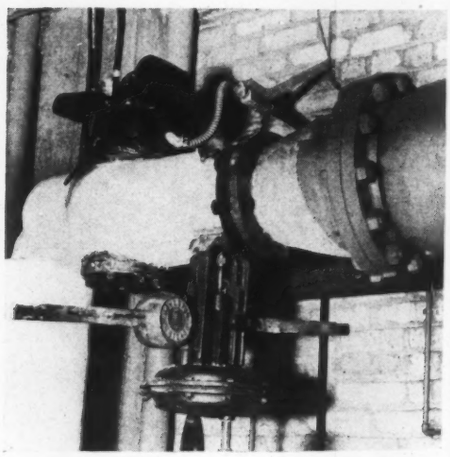


Panel board for the zone control

Indicated Saving Is 22 Per Cent

This newly installed system has been in operation for a little over two months. Consequently it is rather early to state the definite results effected, or the actual amount of fuel which will be saved throughout the entire heating season. However, for the two months of operation, based on degree days, fuel consumption has been reduced 22 per cent. Undoubtedly, comparable savings will be effected when more complete tests and adjustments have been made.

One of the eight reducing valves, which accurately apportions just enough steam for heating 25,000 sq ft of area on each of 18 floors



Determining Presence of Chromates

WHAT is the procedure in determining presence of chromates in a solution with diphenyl carbazide? Mention of this was made in an article "How Can We Stop Corrosion of Our Air Conditioning Equipment?" in the July, 1937, H.P.& A.C.—*Assistant chief chemist.*

REPLY BY C. M. STERNE*: Following is the procedure for making diphenyl carbazide tests with chromium. However, this test is very sensitive, and for determining chromium in solution, I would advise that the potassium iodide, sodium thiosulphate test be used. This is accurate to one part per million, and is used in practically all cases for this type of work.

Diphenyl Carbazide Test: To 5 cc of the solution containing chromium as chromate, two drops of hydrochloric or acetic acid are added, and one drop of an acetic acid solution of diphenyl carbazide (0.2 gram $CO(NH.NH.C_6H_5)_2$ is dissolved in 5 cc glacial acetic acid and diluted to 20 cc with ethyl alcohol). A violet pink color is produced in presence of a chromate. Less than 0.0000001 gram chromium may be detected.

*Chief Engineer, Metropolitan Refining Co., Inc.

New Data for

Refrigeration Piping Design

Ammonia Liquid Line Piping

By R. C. Doremus*

Basic data on the design and installation of piping for industrial and commercial refrigeration are presented in this series of articles. As a refrigeration engineer, Mr. Doremus has had the opportunity to observe jobs which have been poorly designed, has concluded that lack of information is the cause. He therefore makes his data available in this form

AMMONIA has been used for years, yet we are still learning new things about it and developing equipment for its use. It is the intention here to discuss ammonia liquid line piping; a subsequent article will cover suction piping.

The refrigerating engineer, through experience in designing and making installations, has become well informed on refrigeration possibilities and in making ingenious applications of fundamental principles for new processes. He has studied the best method to be used for a particular case and is quite familiar with the material to be cooled, the quantity involved, its specific heat, the drop in temperature desired, the rate of cooling, and the other factors necessary in computing the load in tons of refrigeration. From these essentials, he plans the major items of equipment—such as the compressor of a certain type and speed, the discharge oil trap, the condenser, receiver, low side evaporators, purge drum, purifier and controls.

But these items, as such, are simply individual pieces of equipment. They must be connected with liquid and suction piping to conduct the liquid or gaseous refrigerant from one item of equipment to another in proper sequence and arrangement, and of proper material and size to form a completed system. Of what size, material, and arrangement are these lines to be constructed? Precedent is of little assistance in planning, for hardly any two plants are exactly alike. Approximation is not based on fact and has no part in engineering; guess-work is worse and likely to be disastrous.

The amount of liquid ammonia that must be fed from the liquid receiver through the liquid feed line to the evaporators is 0.4425 lb per minute per ton of refrigeration at 40 F. The amount of ammonia vapor that must be handled is 19,020 cu in. per minute per ton at —40 F and only 2875 cu in. per minute per ton at + 40 F, or a ratio of volumes of about 6.6 to 1 over this temperature range. This emphasizes the need of proportioning the pipe sizes so they will be suitable for different conditions, for a size that would be satisfactory for a certain tonnage at one pressure will not be suitable for that same tonnage at a far different pressure.

The compressor may have a capacity of 100 tons of refrigeration at high back pressures such as used in air conditioning; yet the same compressor at the same speed will produce only 20 tons at very low back pressures—such as used in ice cream hardening, for instance—largely due to the different specific volume of the vapor at various pressures. The cooler or evaporator may be built for any liquid size piping connection from ½ to 4 in., and the suction connection may be suitable for any size suction line from 2 to 10 in. The manufacturer expects a designer to specify sizes according to his piping layout and, therefore, the piping layout must be well planned in accordance with field conditions with due consideration given to the initial capital investment where the installation is made as compared with power, maintenance, and repairs after the system is operating.

Piping Materials for Ammonia

Ammonia has no noticeable effect on lead, glass, aluminum, babbitt, wrought iron, cast iron, semi-steel, steel, nickel steel, and even copper bearing steel where the copper content is not over ½ per cent. Therefore, these materials are used in the construction of equipment and the piping system.

Ammonia in its pure *anhydrous* state has no effect on brass, copper, or bronze. However, in practice it is not pure, and in the presence of water, it forms a strong alkaline solution very corrosive to copper and copper alloys. Inasmuch as there is some water in every large system, these materials are avoided in construction of the piping connections. There are some exceptions, such as bearings and piston rings which are sometimes made of bronze, but these are few and when such materials are used they are hard alloys covered with a protective film of oil. It is, therefore, customary to make evaporators out of steel or aluminum and the pipe mains of steel pipe with cast iron, cast semi-steel or forged steel flanges and fittings. In weights, it is a common practice to install full weight pipe on suction lines 2 in. and larger, and extra heavy pipe for suction lines 1½ in. and smaller (for structural strength between hangers), and for all high pressure lines regardless of size.

Methods of Making Joints

In making gas-tight joints between lengths of pipe and fittings, more diligent care must be used for ammonia and other refrigerants than is usually exercised for steam or water lines. It was formerly the custom, especially in making coils, to heat the fittings and turn them on tinned threads until they creaked sharply and then allow the joint to cool and shrink. Such a joint never would

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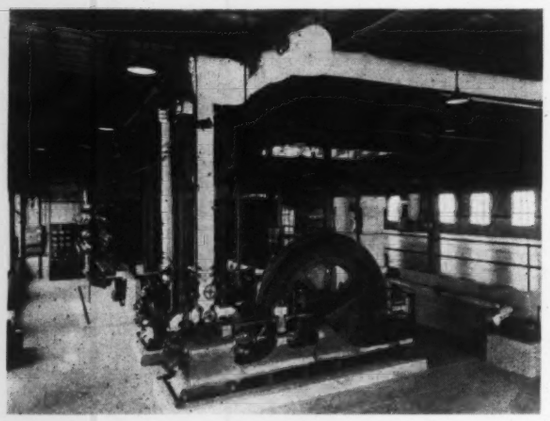
leak after it was made up, but it was rather costly to make all joints of a large system in this manner. Some are made with all threaded connections turned up with a paste of oil and graphite, especially if it is a temporary joint that must be opened up later. The most popular method is to use threaded joints with the threads sealed with a paste of newly mixed litharge and glycerine.

There have been a number of installations during the last five years with welded joints, which eliminates possibility of thread and gasket leaks. This method is quite desirable for it not only eliminates leaks but in my experience is also less costly on sizes 4 in. and larger. Some contractors, therefore, use threaded joints with litharge and glycerine for all sizes up to and including 3 in., and weld all connections 4 in. and larger.



Ammonia compressor and piping

Even in the welded installation some flange or ground joint unions are used, either for final connection to equipment or wherever it might be of advantage to subsequently break into the line for an added item. In flanged joints, gaskets are of the cut ring type in corrugated lead, rubber or superheat composition. Lead or composition gaskets are used mostly in liquid lines for while they are more plastic than resilient, they will not leak, for the line is not subject to shrinkage from changes in temperature. Rubber or composition gaskets are used in coils and suction lines due to their resiliency, for these pipe lines will shrink when run "wet" due to changes in temperature. Lead gaskets are seldom used in a pipe line of fluctuating temperature for they will frequently spring a leak due to the fact that they are plastic and lack resiliency. Ground joint steel unions are popularly used up to 2 in. and in some cases to 3 in. size.

It is probably unnecessary to mention that too much litharge should not be used on threaded joints, for it does no good in making up the joint while the excess will quickly plug suction and liquid strainers. Welding scale will also have the same effect. Therefore, every system should be equipped with an ample suction strainer to prevent compressor trouble and an ample liquid strainer to prevent valves from plugging up.

Sizing the Line

Pure anhydrous liquid ammonia is as clear white and colorless as water and is often difficult to distinguish in a gage glass. It has a density of 41.11 lb per cu ft at 5 F and 37.16 lb per cu ft at 86 F. Its average weight at normal condensing temperatures can be considered as 37 lb per cu ft in the liquid ammonia receiver or liquid feed line. If excessive pressure drops in the liquid feed line are to be avoided, the liquid line piping connections should be sized so that the liquid velocity will not exceed about 2½ ft per sec. On this basis, Table 1 shows suitable pipe sizes.

Table 1—Recommended Maximum Tonnages for Ammonia Liquid Feed Lines

Nominal Extra Heavy Pipe Size, In.	Internal Cross Sectional Area, Sq In.	Tonnage Capacity
⅜	0.141	0—6
½	0.234	6—18
¾	0.433	18—40
1	0.719	40—75
1¼	1.283	75—120
1½	1.767	120—175
2	2.953	175—300
2½	4.238	300—425
3	6.605	425—650
3½	8.888	650—900
4	11.497	900—1150

These tonnages will limit liquid velocity to approx. 2½ feet per second, which is considered good practice in the ordinary installations with average length piping connections, say 125 ft long. On longer lines, use next larger size for same capacity.

Expansion Valves

There are many makes of ammonia expansion valves, both manual and automatic, thermal and magnetic, flanged and screwed, globe, tee and angle in a variety of styles with an assortment of orifices for different liquid flow or tonnage capacities. The designer must know their distinguishing characteristics and limitations and choose the type and size that is best suited for each purpose, for these valves are not universally adaptable to all cases with the same degree of operation success. There are right and wrong valves for each application.

The size of valve orifice determines its capacity with a certain pressure drop. Usually each size of valve will have several rated capacities. It is necessary to use one that is sufficient in size for the load, otherwise there will be an excessive pressure drop and a decrease in capacity. It is likewise possible to use such a large valve that it will be opened in operation a very small amount; in this case, while it may work satisfactorily for a short period of time, the resultant wire drawing effect will wear grooves in the seat very fast. This will cause the valve to leak when shut off and will require a seat renewal (if the valve has a renewable seat), seat regrinding, or replacement of the valve. It is best, therefore, to choose a valve that will have from 50 to 100 per cent more capacity than the required amount of refrigerant so that the valve will be open from 50 to 66 per cent on normal load to prevent wire drawing, and to allow a load to be carried in excess of usual capacity in case the load is fluctuating.

Quite often a valve will be reported "faulty in operation" and upon investigation it will be found "okay," the fault being not with the valve but in its choice. Many times the pressure differential is not given any consideration, whereas it is wise to check it in every case. A valve operating on ice cream or other low temperature work in the summer time will have a large differential, say 200 — 2 = 198 lb per sq in. gage. The same valve might be operating on air conditioning with a differential of 90 — 45 = 45 lb per sq in. gage. Obviously, the same size valve will not pass the same amount of liquid at these two pressure differentials and, therefore,

the pressure conditions mean much in the choice of valve.

The designing engineer knows the low side pressure, for this is fixed by the temperature at which the refrigeration work is to be done. Likewise, he knows the liquid pressure ahead of the expansion valve, for this is usually the condensing pressure and is governed by the temperature of condensing water. Some systems operate only in certain seasons while others are year around installations. Therefore, the lowest back pressure of the operating season should be determined.

In addition to condensing water temperature, another factor affecting liquid line pressure ahead of the expansion valve is the static height of a valve above the condenser. In the above mentioned case, if the condenser and evaporator were each located in a basement, a valve should be chosen suitable for the full capacity at a 45 lb differential pressure. If, however, the condenser and compressor were in the basement and the evaporator on the 8th floor 128 ft above the condenser the differential would be $90 - (128 \times 0.252) - 45 = 13$ lb instead of 45 lb. In fact, if the height in this case were 180 ft, the head pressure due to the static height would be 45 lb and there would be absolutely no liquid flow regardless of valve size. In such an instance, there are three remedies:

(1) Either lower the evaporator or raise the condenser to reduce the static head between the two items (often impossible).

(2) Throttle the condenser water valve to raise the head pressure (inefficient).

(3) Use an ammonia liquid pump to raise the liquid to the desired head (additional equipment and operating cost).

To illustrate the mechanics of an installation with a liquid ammonia riser, suppose we have a 25 ton load to be operated at 45 lb suction pressure and that the evaporator is to be situated 125 ft above the condenser where the condenser pressure is 165 lb per sq in. gage. We will assume that the discharge gas has been liquified in the condenser from a saturated condition and that there is no liquid subcooling. The liquid pressure in the basement is the same as the condensing pressure, namely, 165 lb, and if the evaporator were in the basement, the differential pressure for liquid flow through the liquid feed line and control valves would be $165 - 45 = 120$ lb.

However, on the upper floor the liquid pressure is reduced due to the static head of liquid ammonia in the liquid feed line to $165 - (125 \times 0.252) = 133.5$ lb and the differential across the expansion valve is reduced to $133.5 - 45 = 88.5$ lb.

Another factor that must be considered is the gas formed by this reduction in pressure:

Heat of liquid sat. @ 165 lb ..... 143.1 Btu per lb
Heat of liquid sat. @ 133.5 lb..... 129.8 Btu per lb

Reduction ..... 13.3 Btu per lb

$13.3 \div 143.1 = 9.3$ per cent of all liquid leaving receiver boils off into gas in the riser.

The total amount of liquid ammonia required fed for the load is $25 \times 0.4218 = 10.55$ lb per minute.

This liquid occupies a volume ahead of the expansion valve at 133.5 lb pressure of $10.55 \times 0.02661 \times 1728 = 485$ cu in.

The amount of liquid that has changed to gas in the riser ahead of this expansion valve due to pressure reduction is 9.3 per cent of $10.55 = 0.98$ lb.

The volume of this vapor is $0.98 \times 2.02 \times 1728 = 3420.7$ cu in.

Thus the valve must feed not only 485 cu in. of liquid per minute at a reduced pressure differential of 88.5 lb per sq in., but also about seven times as much gas in volume as liquid. If no provision is made for this gas, a very small amount of liquid will be passed with a consequent reduction in capacity. Thus, it is not so much a question of maintaining a small pressure drop as it is of choosing a valve with sufficient capacity at the available pressure differential.

Magnetic Liquid Shut-off Valves

The small ammonia commercial refrigeration system having only one compressor and perhaps one or two evaporators is simple in construction and does not involve magnetic valve controls. The larger multiple commercial and industrial systems do involve magnetic liquid valves ahead of the expansion valves in a tandem arrangement. (All of the above mentioned factors affecting expansion valves also apply to magnetic liquid shut-off valves for these, too, are procurable in a variety of makes, sizes, types, and with a number of orifices for various capacities).

Inasmuch as the piping connections are made with a magnetic shut-off valve ahead of an expansion valve, the whole pressure differential is not available for each valve but naturally is divided between the two items. The shut-off valves usually have large parts so that about 10 per cent of the total pressure differential may be applied to the shut-off valve and 90 per cent or so to the expansion valve. However, if the magnetic shut-off valve is too small in capacity, its pressure drop will be excessive—which will leave a small amount of the total differential available for the expansion valve. Such an error reduces the capacity of the expansion valve, which might otherwise be satisfactory, and this means a possible later change in one valve or the other.

Tank room, showing liquid and suction mains

Oil and Liquid Ammonia

With low pressure refrigerants, such as "Freon-12" and methyl chloride, the oils used are very miscible with the liquid refrigerant. In the case of ammonia, the oils used are not considered as being miscible with the liquid refrigerant, yet they are carried along with both gas and

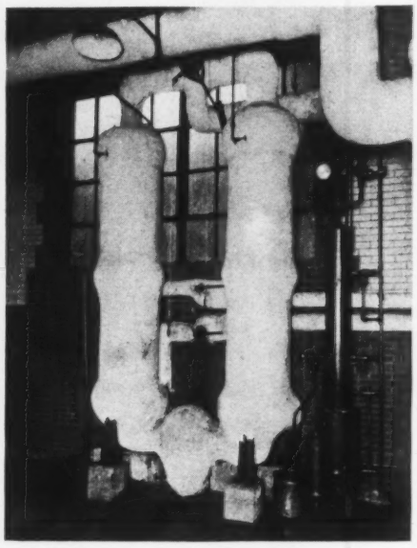
liquid and the lines must be installed to provide for this.

The oil used in an ammonia refrigeration compressor system must be a clear, low temperature oil free of acid and neutral to ammonia, of the following general specifications:

Gravity	21.5 to 22Bé
Flash point	340 to 350 F
Combustion point	500 to 525 F
Saybolt viscosity @ 100 F	150 to 160 sec
Saybolt viscosity @ 210 F	43 to 44 sec
Pour point	—25 to —40 F

In machines using splash oiling, there is a strong tendency to pump oil, especially when liquid slugs back in the suction gas with a suction connection to the crankcase. This is largely eliminated in compressors using an oil pump and drilled rods and suction inlet in the column instead of the crankcase. Nevertheless, oil is carried along with the discharge gas and hence a discharge oil trap is used to separate as much as possible. Oil passing this trap will flow through the condenser with the liquid into the receiver where it will separate by gravity to the bottom. It should be drawn off from the oil trap and receiver periodically, but generally this is not done often enough. Frequently, also, too much oil is used in a system. Oil then passes along with the liquid ammonia to the expansion valves where it causes trouble by freezing to a grease, if not low enough in pour test, interfering with the free passage of liquid ammonia through the valves.

This emphasizes the need of using a good grade of oil with a low pour test and ample sized valves to eliminate such restrictions. Oil with too high a pour test congeals in the evaporator due to the low temperature and coats the inside of the pipes with grease, interfering with the heat transfer and diminishing the low side capacity. For this reason, the large plant will usually include a combination hot gas defrosting and oil pump-out line which besides defrosting the coil, will permit the hot gas to melt any congealed oil so that it is fluid enough to drain to the liquid ammonia inlet at the bottom of the evaporator and separate from the liquid ammonia for pumping back to the ammonia purifier for reclaiming.



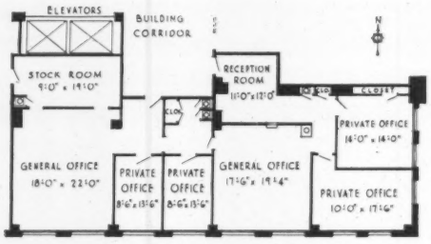
Dehydrator and ammonia purifier

How Should These Offices Be Air Conditioned?

A Question for Readers to Answer

HERE is a question that's particularly important because of its wide application and the considerations which are involved in preparing an answer to it. How do you think a job like this should be done?

Readers are invited to send answers to The Editor, HEATING, PIPING AND AIR CONDITIONING, 6 North Michigan Avenue, Chicago, Illinois; those published will be paid for at regular rates. Note that a detailed design is not what is desired, but general recommendations and helpful comments on advantages and disadvantages which will enable the prospective owner to determine what he can do about air conditioning, and how he can do it.



"We are tenants of a large office building in a middle western city, and are interested in providing our offices with winter air conditioning at least, and possibly year 'round conditioning, for the comfort and efficiency of our employees. What general type of system would be most suitable for us, and what would be its advantages and disadvantages? We do not want a detailed design for a system, but rather general recommendations and helpful comments.

"Our offices comprise the south-east corner of the top floor of the building, as indicated in the sketch. The building is heated entirely by direct radiation, vacuum system, and has no air conditioned areas except for stores and shops on the ground floor. Our lease is for a five year period (of which one year has already run) and while we do not contemplate moving when it expires, the fact that we are building tenants and not building owners no doubt affects the matter."

Ford Motor Company

Sets High Air Conditioning Standards

By J. J. Floreth*

ALTHOUGH no detailed records are available, it is probably safe to say that the Ford Motor Co. is the largest single user of modern air conditioning in the industrial world. Embodying all forms of atmospheric treatment for industrial processes, and including increasingly larger areas conditioned for the comfort of occupants in their many plants and other buildings throughout the world, Ford's total air conditioning is believed to represent the greatest program and investment under a single ownership today. This program appears by no means complete, if it may be judged from the steady expansion witnessed during the past three years, and this expansion in itself seems to be the greatest proof that Ford has found air conditioning pays in increased production, more accurate processing, steadier output, and particularly increased efficiency and better health of all classes of workers.

Ford's air conditioning program started many years ago with the controlling of air required in several basic processes of manufacture. This was the nucleus from which has grown the extensive process air conditioning applied to very many phases of manufacturing, production and research. Back in those early days the control of air temperature naturally claimed the first attention of the Ford engineers, but today each of the fundamental factors of air conditioning has been studied separately in relation to its effect upon a particular process, and either separated or combined to produce the exact atmosphere best suited to the problem. For example, uniform temperature has been found essential in precision manufacture of parts, and we find the room in which cylinders are diamond-bored, the room in which crankshafts are ground to close tolerances, and similar manufacturing areas employing apparatus both to heat and cool the air supplied uniformly to all parts of the space by duct systems. In experimental laboratories, test rooms, and certain special manufacturing processes, the moisture content of the air has also been placed under close control and combined with air cleaning apparatus to produce an atmosphere in which all of the functions of complete air conditioning are regulated to assist the work performed. Ford was among the earliest pioneers in harnessing the machine, power, and raw materials of Nature for the increased comfort of mankind and has steadily been harnessing air to supplement these basic forces.

The extent to which this has been carried is strikingly borne out by a test room now under construction. Most of us visualize air conditioning in terms of temperatures between 60 and 90 F, with the conditioned air distributed gently to avoid all possible drafts. Ford's latest air conditioning installation has been carefully designed to produce a temperature 30 F below zero and a gale of 70 miles per hour. These requirements were established to further the testing of Ford automobiles under the severest possible weather conditions likely to be encountered, and combine the functions of a "cold test room" and the experiments conducted in what is commonly known as a "wind tunnel."

Conditions Air for Workers' Comfort

Interesting as are Ford's applications of industrial air conditioning, the rapid extension of the program to the strictly human comfort field during the past five years is more significant. The managements of many large industrial firms have seen the direct return to be obtained from the application of air conditioning to particular processes of manufacturing, inasmuch as this return is indicated by a measurable increase in production rate, quality of product, or reduction of spoilage, and consequently measurable in dollars profit. Likewise the executive heads of department stores, theaters, restaurants and other enterprises wherein success and profits depend upon the buying public entering their doors, were among the first to recognize and evaluate the direct increase in business brought about by human comfort air conditioning. However, Ford has been among the first to look ahead still further and weigh the returns to be obtained from air conditioning private and general offices, factory work rooms, first aid rooms, laboratories and similar enclosures solely for the increased comfort of the occupants. These returns cannot be measured directly, but must be evaluated from the increased efficiency, more accurate work, better health, and last, but not necessarily least, the increased good will which is established between the worker and his employer. It seems certain that this last factor alone accounts for many of Ford's human comfort installations.

Ford's program in the human comfort field is rapidly including almost all office, laboratory and display room areas, not only in this country, but abroad. One of the first complete installations involving an entire building,

*Air Conditioning Engineer, York Ice Machinery Corp.

Ford Motor's program of and investment in air conditioning is believed to be the largest under single ownership in modern industry. In plants and buildings throughout the world, air conditioning systems designed and installed to meet the standards which have been set up by Ford engineers are serving manufacturing processes and human comfort. . . . What these standards are and the features incorporated in air conditioning systems for this large user are explained

was made in the Engineering Laboratories at Dearborn, Mich., which is a one story building approximately 800 ft long by 200 ft wide, housing machine shops, testing rooms and other departments engaged in the research and development of not only the Ford automobile, but many other branches of mechanical science in which Mr. Henry Ford is interested. Various executive offices and meeting rooms are also situated in this structure, which is air conditioned throughout. A visitor entering this building is not only impressed with the cool refreshing atmosphere, and the complete concealment of the entire air conditioning apparatus and duct work, but cannot help but marvel at the beautiful architecture and appearance of the building itself. From the impressive exterior, across the front of which is inscribed in a roll of honor the names of leaders of science to which mankind owes so much, to the laboratory floor of close laid, highly polished hardwood extending the entire length of the building, it represents the combining of Labor with Beauty, to which air conditioning has been added to complete the symbol.

The Engineering Building, Administration Building, the Ford Rotunda, and the Dearborn Inn were also among the first complete building installations made by Ford starting in 1933. This group, at Dearborn, totals over 450,000 sq ft of floor area and requires 1260 tons of refrigeration during the summer season to cool and dehumidify the air supplied to the occupied zones. Each installation provides year round comfort and is complete in every respect, including apparatus for filtering, washing, humidifying and dehumidifying, cooling or heating the air circulated by the separate fan systems 12 months of the year. These buildings can be said to be only the hub from which Ford's human comfort program is being extended to the far-flung reaches of the organization. Recent installations have included 16 branch assembly plants at Somerville, Mass., Buffalo, N. Y., Edgewater, N. J., Chester, Pa., Norfolk, Va., Memphis, Tenn, Louisville, Ky., Dallas, Tex., Kansas City, Mo., Jacksonville, Fla., New Orleans, La., St. Paul, Minn., Long Beach, Calif., Chicago, Ill., Sao Paulo, Brazil, and Buenos Aires, Argentina. The Ford showrooms and offices at 1710 Broadway, New York City, have just been completely air conditioned in connection with a remodeling of the building, which has been a center of interest at the recent automobile shows. In each of the assembly plants the installations provide for year around comfort in general offices, executive offices, factory offices, display rooms, lobby, first aid rooms and assembly rooms. Complete in every respect, each installation again carries out the concealed design and attractive appearance so noticeable in the larger buildings at Dearborn. Ford appears to have but one standard of air conditioning—namely, the highest—and whether providing comfort for a top executive, a department group or a time-keeper in his small factory office, the design, construction, workmanship and finished appearance of the installation conform to the highest standards of the industry.

Air conditioned branch assembly plant, indicating the excellence of Ford construction standards

Ford's standards of air conditioning are the result of careful consideration given each individual problem by Ford engineers and the air conditioning manufacturers with whom they cooperate; but surprisingly enough, they appear as an inconspicuous part of the standards prevailing throughout every phase of Ford construction. Only the air conditioning engineer or trained observer would note the refinements of design and construction which have gone into the making of even the sub-branch installations, for to the casual visitor they merely appear to form a part of the substantial construction and finished appearance noticeable from the managers' office to the factory spaces in every Ford plant.

Ford's Standards of Air Conditioning

Yet these standards are not the result of elaborate expenditures, or common engineering knowledge touched up with the brush of unlimited resources, but represent careful study, experiment, research, and trial and error experience on the part of Ford engineers. Ford has turned to leading manufacturers of air conditioning in the making of these installations, in order to obtain the best experience available in the industry, and then has gone still further by conducting experiments on materials of every kind that enter into a project of this type. These experiments include the investigation of all types of apparatus, materials used in insulating, sound proofing, and isolating, the durability of piping and other metal parts when subjected to various refrigerants, steam pressures, chemicals and other substances to which they are continually exposed in the operation of a system. Various methods of air distribution, temperature control, and air filtration have also been studied and tried, either to be rejected or included in that group of acceptable materials and equipment which today form the basis of all Ford installations. That such a procedure on the part of a purchaser of air conditioning is extremely unusual, is at once apparent to those familiar with the industry, bearing in mind that the business of the Ford Motor Co. is the manufacture of automobiles and not the installation of air conditioning. But that it has accomplished unusual results must also be admitted after an inspection of a Ford installation.

Ford's air conditioning specifications establish design conditions of 80 F degrees dry bulb temperature and 45 per cent relative humidity to be maintained in the conditioned spaces when outside temperatures are at 95 F dry bulb and 75 F wet bulb, the maximum normally encountered during the summer season. Inside winter conditions of 70 F dry bulb with 30 per cent relative humidity, when the outside temperature is minus 30 F in St. Paul or plus 10 F in Long Beach, Calif., are also standard throughout Ford specifications for human comfort air conditioning.

While these design conditions are not unique as far as the industry is concerned, they are indicative of the standard of air conditioning maintained by Ford. Eighty degrees dry bulb and 50 per cent relative humidity has,

in recent years, represented very acceptable comfort conditions in the majority of buildings air conditioned throughout the country, and many specifications have been based on 80 F and 55 per cent in an effort to reduce the initial cost of certain installations. Although these conditions have proven acceptable, Ford desires that added refinement of comfort which is obtained by lowering the relative humidity to 45 per cent at the same 80 F dry bulb, thereby increasing the evaporative cooling effect on the skin.

All materials entering into the construction of a Ford air conditioning installation are new and of the best quality, and while this is not an unusual construction specification, the degree to which it is investigated and checked by Ford engineers is not common. A typical example of this is Ford's detailed investigation of insulating materials, particularly for use on large surfaces, such as an exposed ceiling under a hot attic space. Insulation is always considered for areas of this type as the operating costs of each installation are weighed with equal importance to initial cost. If the additional investment can be justified over a period of years the initial cost becomes a secondary consideration, and the particular area to be insulated is studied in relation to the materials available on the market.

All electric motors used on Ford air conditioning installations and throughout Ford plants in general are of special design and construction known to motor manufacturers as the "Ford Standard." These motors are totally enclosed, fan ventilated, of ball bearing design suitable for mounting in any position, and are manufactured to construction specifications, known as N.E.M.A. standard, designed to provide given over-load ratings, starting torque, current inrush and other characteristics at normal temperature rise. Copper piping is preferred by Ford, especially when using "Freon-12" refrigerant, although steel piping is accepted for some installations where welded construction is used throughout.

Workmanship and Appearance Stressed

Ford's standards of workmanship and appearance are the same whether an installation is being made in an executive's office or a factory space, and specify all exposed duct work, piping and other construction materials to be furred in and painted to match existing surfaces. Air distributing grilles must be of high velocity directional flow type and are generally installed with antique bronze finish in office spaces and chromium finish in first aid rooms. Ducts, conduits and piping are installed absolutely plumb and level to the eighth of an inch, and aligned with each other and adjacent surfaces to present the neatest possible finished appearance. All piping bends and changes in direction of ducts are made at 90 deg angles without exception, which also tends to improve the finished appearance of even the exposed parts of the installation in equipment and machinery rooms. All parts of the system, including exposed ducts, piping, insulated surfaces, compressors, pumps, fans and other equipment are painted an approriate color either to match adjacent surfaces or conform to Ford's standard of machinery appearance. The degree to which this is sometimes carried can be witnessed at the power plant near the Experimental Laboratories building at Dearborn. Here, even the layman visitor will be impressed with the architectually beautiful building that houses a 3500 hp steam boiler plant and generators mounted on a white tile floor with every piece of piping, every valve, nut, bolt, or bracket finished in black enamel or chromium. When one realizes that this gigantic power plant is not an exhibit on display at some international exposition, but is daily a unit of service delivering electric current to many of the buildings at Dearborn, the standard of workmanship and finished appearance maintained is forcibly emphasized.

The company normally issues only a general specification covering any air conditioning project, allowing bidders considerable freedom and scope in engineering and design. These specifications are usually supplemented by having one of the engineers from the power and construction department at Detroit meet with the bidders at the particular premises under consideration, in order to establish more accurately the various factors which will enter into the design of the system, location of equipment, treatment of office interiors, etc. When this procedure is not possible, as in the case of those plants situated in South America or other foreign countries, a detailed study of the premises is made from the plans available in Detroit, and complete instructions forwarded to the local plant superintendent.

The Ford engineer meeting with the bidders may indicate the engineering features and design arrangements preferred for that particular installation, but more often Ford prefers to obtain the experience and design ability of the manufacturers and contractors who have been invited to bid on the project, as evidenced by the several designs available for consideration after the bids have been received. All bidders are, of course, advised of Ford's standards of workmanship and materials; temperatures, humidities, people loading and other factors on which to base the design of the system; and the extent of work to be included in the bid. This procedure for the instruction of bidders not only results in each bid being received on the same basis without the necessity and expense of preparing elaborate and detailed specifications, but also gives each bidder an opportunity to discuss and settle right at the premises all of the many questions which are bound to arise in spite of the care with which specifications are often prepared and instructions issued. However, this method does not confine the design ingenuity to one organization, as is common with most detailed specifications, but draws on the experience, ingenuity, and engineering ability of each of the several companies bidding.

Each bid received is then carefully studied by Ford engineers representing both the power and construction department and the engineering laboratories and ample opportunity is given each bidder's engineers to explain and discuss the features incorporated in the various designs offered. From the data, specifications and drawings submitted with each bid, and the discussions which supplement them, Ford engineers are then in a position to judge the merits and possible disadvantages of each design offered, and recommend to the management the expenditure required, the equipment they judge most suitable and the particular design which will best accomplish the results desired. Although the initial cost is

naturally a prime consideration, Ford always evaluates engineering features, with the result that the lowest bid received on a project may not necessarily be awarded the work. In the course of construction or during the preparation of final construction drawings for Ford's approval, Ford engineers may often suggest minor revisions to improve the arrangement of the system or better adapt it to available space which is always at a premium; but the change in cost to the contractor involved by these changes is given fair consideration and adjustments made to the contract price when necessary. On larger projects Ford normally has an inspector at the job during the construction period both to avoid delay by being readily available to authorize minor changes made necessary by unforeseen obstacles, and to insure the standard of workmanship and materials desired. A final inspection and acceptance of the installation is made by a member of the Detroit engineering staff.

Air Condition Assembly Lines?

There appears to be little doubt that Ford's human comfort air conditioning program will be expanded rapidly in the next five years, and may some day include even the vast factory spaces housing the manufacturing and assembly lines. The standard of these installations undoubtedly destines them to be among the most outstanding of their type for years to come, in spite of the marked development which takes place each year in the industry, and the continually improved equipment designs available.

[To show how these standards work out in practice, a later article will describe the air conditioning of a new branch assembly plant.]

Sewage Disposal Plant Makes Its Own Fuel

THE refuse it disposes of furnishes the fuel to heat the building and supply the heat requirements of the various processes at the new sewage disposal plant for La Crosse, Wis.

At the plant, liquids and solids are separated and treated by a series of intricate processes. The liquid, 90 per cent cleaner than when it entered the plant, is sent to the river through under-ground channels.

The disposal of the solids remains. This is carried on in two digestion tanks in a so-called multi-staged digestion process. A bacteriological process sets in, and the microbes in the sewage are set to work destroying the sludge. It is here that the gas is obtained that is utilized in operating the entire plant. 85 per cent of the gas is generated in the primary digestion tank as the process of fermentation and decomposition is going on. This process materially reduces the quantity of sludge. When the plant produces 70 gpm of sludge, enough gas is secured to completely operate the layout.

The two digestion tanks are 65 ft in diameter, 22 and 25 ft high respectively. They have floating covers of steel for the capture of gas. The primary tank is the only one that is heated. At definite intervals the sludge passes from the primary tank to the secondary tank to complete the process. From the secondary tank the sludge is taken to specially constructed beds that resemble tennis courts. All the liquid that remains filters into the sand and is carried by means of a tile arrangement to the river. Dry material is then used as fertilizer with no offensive odor remaining.

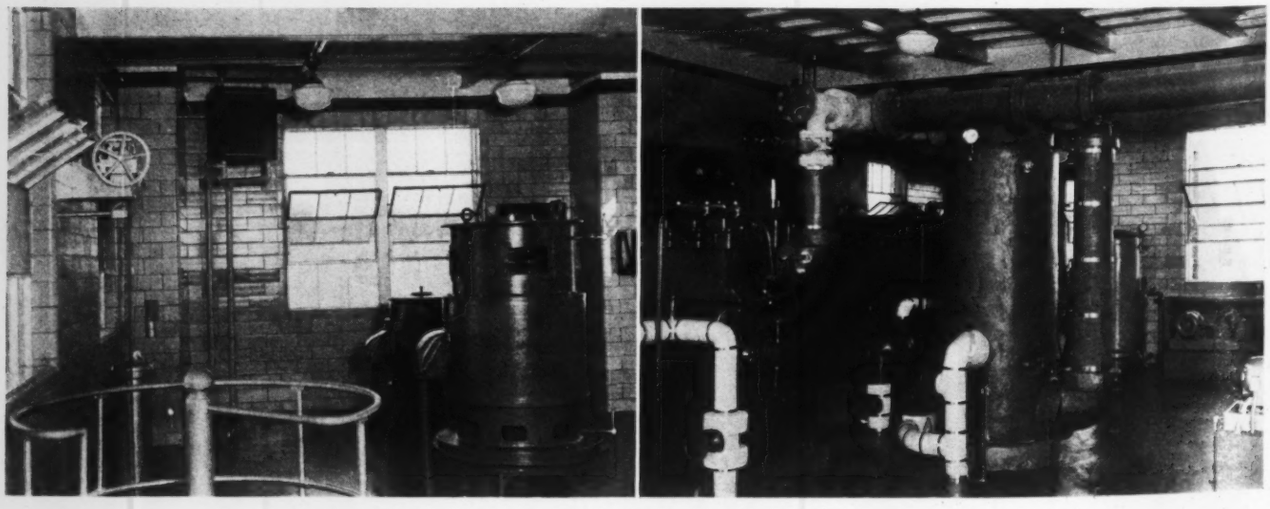
The gas from the digestion tanks is piped back to the main building directly to a 90 hp internal combustion engine particularly designed to burn sewage gas as a fuel but which will operate on gasoline in an emergency. The jacket water, semi-hot from the engine radiator, is piped from the engine to a special tank where it is heated to the proper temperature by the exhaust gas from the engine.

The hot water is then circulated through the various wall type convectors and unit heaters scattered throughout the plant.

This system allows the city to save upwards of $6000 a year in fuel and power.

Photos courtesy the Trane Co.

Unit heater in engine room, left. Right, internal combustion engine and exhaust gas boiler



E. Vernon Hill's* Personal Comments

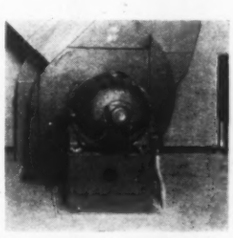
SOME months ago I commented on the classification of engineers engaged in air conditioning work—the consulting engineer, the application engineer, the sales engineer, and several others. I suggested that the classification at the present time was indefinite and that the American Society of Heating and Ventilating Engineers could render a real service by adopting a definite and authoritative classification.

Perhaps I was overly optimistic, perhaps such a classification is difficult or even impossible at the present time. The picture is constantly changing and the duties and responsibilities that were borne almost entirely by the consulting engineer a few years ago, are now taken over in part, in some distribution organizations at least, by the application engineer, the sales engineer and others.

There is another figure that now begins to loom large in the picture. I refer to the service man, who is becoming more and more necessary in the somewhat complicated installations for complete air conditioning.

The sales engineer has a comparatively easy task, at least from the technical standpoint. He makes the sale, presumably, and collects the selling commission. It is essential of course, that the sales engineer have a fairly comprehensive background of engineering training and experience; it not only aids him in making the sale, but it frequently prevents him from making expensive mistakes. However, he has the support and assistance of the application and layout engineers in his organization and his shortcomings in technical knowledge are not particularly serious, provided that his judgment is sound.

The consulting engineer, or in distributing organizations the application engineer, is supposed to be the best qualified man technically in the organization. It is his job to calculate heating and cooling loads, determine the size and type of equipment necessary, locate the equipment where it should go, and assemble, on paper, the various component parts of the system. But even the application engineer need not be a walking encyclopedia of knowledge; he has his text books to which he can refer, catalog information and other data on the equipment he selects, and able assistance by representatives of manufacturers.



The service man, on the contrary, is in a much more difficult position. He has nothing to guide him except his own knowledge and experience. I speak in this connection of the service man worthy of the name, not merely the repair man who must be told what to do, but the service man who finds out what is to be done. He may or may not be a technical man—often he is not—but he must know the important fundamentals of engineering and he must be steeped in that lore of usable knowledge that comes only with experience.

He comes on the job after the sales engineer and the designing, layout and application engineers have finished. He must make the job work to the satisfaction of the customer; he must know all that the others know of operating equipment and something besides. Otherwise his presence is useless.

He does not visit the job with reference books, charts, tables and a slide rule, he comes with a leather bag (usually quite disreputable) containing some wrenches, plyers, a screw driver, a halide torch, thermometer, gages and a miscellaneous assortment of fittings.

It is not sufficient that the service man know what *should be* in the crankcase of the compressor; he must know what *is* contained therein or he must find out. He looks at a shell and tube condenser and from his knowledge and experience determines whether or not it is adequate. The size and arrangement of the liquid and suction lines, the design and position of the expansion coil, the amount of air and its velocity through the coil—all of these numerous and important factors he weighs and instinctively judges on his preliminary inspection.

But the competent service man is not one who relies too much on appearances and arrangements, the feel of the piping and of the compressor heads to his hands—he uses precision instruments and determines actual conditions by careful tests. A good service man is a good diagnostician and in engineering as in medicine, accurate diagnosis is the first step in correct treatment. If the physician knows what is wrong with his patient, his medical books and experience will make the selection of his treatment relatively simple. So with the service man. If he has the knowledge and experience that leads him directly to the cause of the trouble, the corrective measures are not hard to find.

I had lunch with an old friend some time ago who wanted to unburden himself about the troubles he was having with a fairly complete and rather expensive air conditioning system that was installed last year in his new home. It was not what he had expected; it was not satisfactory. He told me that it did not heat uniformly in winter and did not cool adequately in summer.

A friend of his who happened to be the president of a large air conditioning concern visited his home and looked over the installation in the hope that he could offer some valuable suggestions. His friend however, frankly disclaimed his ability to cope with the situation.

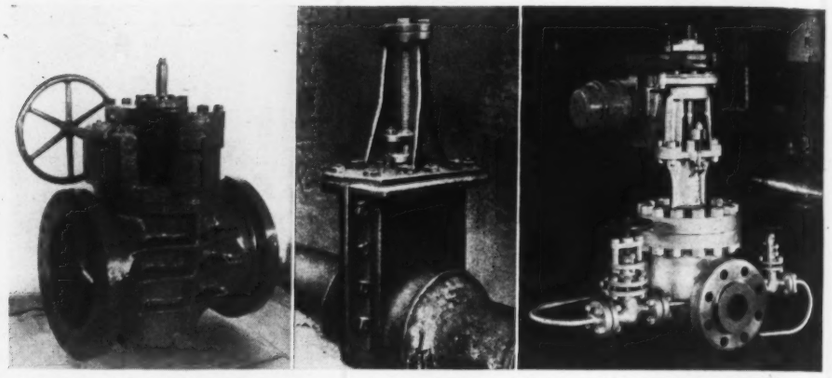
I advised my friend that the president or vice-president or even the chief engineer was not the man he required, but a good service man of sound judgment and long experience. I suggested the name of one I happened to know quite well. Some weeks later I saw my friend again. His face was wreathed in smiles and he thanked me for my advice—a thing seldom done. He said the service man I had recommended came out and looked at the installation, made only a few tests and some minor changes and adjustments.

"I think," he said, "he changed the pulley on the fan, threw away my filters and substituted a different kind, put some gas in the system, adjusted some of the valves and now everything is working to my entire satisfaction."

One situation at least, where the service man is better than the president.

*Director of Research and Education, Refrigeration and Air Conditioning Institute. Member of Board of Consulting and Contributing Editors.

Valves



—a Review of Available Types and Their Features

VALVES are perhaps the most important items of equipment used in piping engineering, and consequently it is felt that a general review of their evolution and a discussion of the various features of modern types will be of value and interest to those who design, install, operate and maintain piping systems. The illustrations are intended to represent types, and are published to amplify the text.

Early Applications

Cocks were used for controlling the flow of steam in the latter part of the 18th century, when mechanical power was first enlisted as an aid to manpower in industry. This is the simplest form of valve in existence as it has only two major parts. It has the disadvantage that if the plug becomes loosened, or the seat leaks, the fluid contained may escape outside of the pipe. It is also difficult to operate and has a great propensity for sticking. This type of valve, however, still persists and is extensively used at the present time.

Above: **Fig. 1—Lubricated plug valve . . . Fig. 2—Early gate valve installed in New York City water supply system . . . Fig. 3—A modern steel gate valve rated for 1500 lb working steam pressure at 900 F**

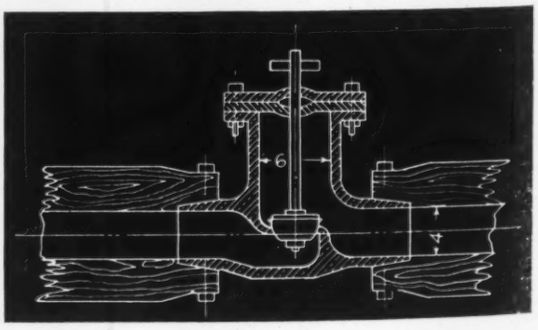
A greatly improved valve of this type that has been applied with marked success during the past few years to an increasing number of service conditions is the lubricated plug valve. While this valve has a rotating plug like the ordinary cock, it also has the additional features of a closed body with a packed stuffing box surrounding the stem to prevent leakage to the outside, and a pressure greasing system to lubricate the plug so that it will turn freely and will not stick when it stands in one position for a long time without being operated. The film of lubricant also aids in sealing the joint between the body and the plug and thus prevents leakage to the downstream side of the valve. This type of valve has practically a straightway flow, and also has the unique advantage of keeping the major portion of its seating surface covered at all times, thus protecting it from chemical attack, erosion, or incrustation by the fluid in the pipe. Another advantage is that hard particles of foreign matter which might injure the valve have little or no opportunity to work in between the seating surfaces.

Fig. 1 shows a modern venturi type lubricated plug valve used on a high pressure natural gas line. Valves of this type are made of various materials for high and low pressures, both with full port area and of the venturi type in which the port area is reduced.

Gate valves were used at an early date for water. Fig. 2 shows one that was installed in a water supply system in New York City early in the 19th century. The body was made of cast iron, the stem, yoke, rods and bolts were of wrought iron, and the disc was a sheet of cast iron connected to the stem by a loose link. A wooden pipe line made from bored logs was used throughout the water system, with the exception of the fittings and connections at the storage tank, which were of cast iron. It is interesting to compare this early gate valve with Fig. 3, a modern cast steel gate valve built to meet the requirements of American Standard B16e for 1500 lb working steam pressure at 900 F.

There has been no fundamental change in the valve mechanism, but the design has been perfected so that a tight closure can be secured. The various parts of the valve have been strengthened, the objectionable joint around the body has been eliminated, and the metal used in the valve, instead of being cast iron, is a high grade steel suitable for the high pressures and temperatures in use today. This illustration is typical of the type of development that has

Fig. 4—Old stop valve of the globe type with wooden disc and sliding stem. It is presumed that such valves were mounted with the pressure on top of the disc for no means were provided for holding the valve closed



Part 1.

By F. H. Morehead*

The vital part that valves play in modern piping practice is exemplified by the many kinds of valves which are used for controlling and regulating "industry's most important transportation system" . . . The author has attempted in this review to present a general picture of the basic types of valves, and to indicate, insofar as is possible, the particular applications, inherent advantages, and limitations of each

been taking place in the valve and fittings industry. Much constructive work has been done in improving design, materials, workmanship and manufacturing processes which are essential factors in producing high quality valves at a cost within the range of a highly competitive market.

The first cast iron water mains in Philadelphia were laid in 1820 and previous to that time the pipes were made of bored spruce-pine logs. Stop valves were of the globe type with a wooden disc and sliding stem, Fig. 4. It is presumed that the valves were mounted with the pressure on top of the disc because no means were provided for holding the valve closed, except the pressure of the water. Neither were there means for holding the valve open. This was probably accomplished by placing a block under the tee handle. This type of valve was used from 1801 to 1844.

General Classification of Valves

A fundamental difference in the design of valves which very logically serves as the basis of a general classification is found in the path of the fluid through a wide open valve, and on the basis of this characteristic all valves may be grouped into three general classes as follows:

Class 1—Valves in which a practically straight way, constant velocity, flow passage is provided when the closure member is wide open.

Class 2—Valves that are intermediate between Classes 1 and 3.

Class 3—Valves in which a tortuous flow passage is provided when the closure member is wide open, and complete drainage of a horizontal pipe line cannot be accomplished except by means of supplementary drain connections.

Obviously, Class 1 valves offer a distinct advantage in flow characteristics, and a properly pitched horizontal pipe line equipped with valves of this type may be completely drained by simply opening the valves and permitting the pipe line contents to flow out by gravity.

A number of possible valve constructions are necessarily included in Class 2, some of which approach very closely to Class 1 valves in flow characteristics, while others border on the characteristics of Class 3 valves.

Class 3 valves have the disadvantage of creating more pressure drop through the valve, and in addition to complicating the problem of draining the pipe line, also present an obstruction to flow that promotes the accumulation of sediment if any is present in the pipe line fluid.

Another fundamental difference in the design of valves is found in the nature of the opening and closing mechanisms. The movement of the closure member relative to the seat determines in large measure the conditions to which the valve seats are subjected in service, and consequently has a very definite bearing on the life of the valve. All valves for regulating and stopping flow, regardless of their general type and special features of design, must be capable of both partially and completely closing the orifice through which the pipe line fluid flows, and in view of the fact that the useful life of a valve is ordinarily limited by the life of its seat, it appears entirely logical to set up a general classification of valves based on the movement of the closure member relative to the seat. With this end in view, the many possible mechanisms for restricting and completely closing the port of a valve seat may be grouped into three general classes:

Class A—Valves in which the disc or closure member travels directly toward and away from the face of the seat.

Class B—Valves that are intermediate between Classes A and C.

Class C—Valves in which the disc or closure member travels directly across the face of the seat.

In Class A valves the closure member is pressed directly against the seat of the valve and consequently there is no tendency toward wearing, scoring, galling and seizing in service due to the seating surfaces sliding across each other under pressure. However, this construction has the disadvantage that the fluid in passing through the port of the valve seat travels across the seating surfaces, and consequently subjects them to erosion and wire drawing.

Class B necessarily covers a rather diversified group of valves, including a variety of types that may partake of the characteristics of either or both Class A and Class C valves, depending on their design.

In Class C valves the tendency toward erosion and wire drawing is eliminated, but the tendency toward wearing, scoring, galling and seizing due to the seating surfaces sliding across each other under pressure is always present.

There are of course numerous other variations in the design of valves which might possibly be used as a basis of classification, such as whether the seating surfaces are shielded from the action of the pipe line fluid for all positions of the closure member, whether the stem threads are shielded from the action of the pipe line fluid, whether the rate of closure is fast or slow, whether the seats are readily renewable, etc., but the fundamental differences, in the opinion of the writer, lie in the two general classifications based on flow characteristics and the movement of the closure member relative to the seat.

Table 1 shows prevailing types of valves in common

Table 1—Classification of Valves

	Class 1	Class 2	Class 3
Class A	Swing check valves	Angle valves Y valves Lift check valves, angle type	Globe valves Lift check valves, globe type
Class B	Wedge gate valves D. D. taper seat gates	Needlepoint angle valves Wedge gates—venturi type D. D. type seat gates—venturi type	Needlepoint globe valves
Class C	Cocks Lubricated plug valves, full area D. D. parallel seat gate valves	Cocks—venturi type Lubricated plug valves—reduced area D. D. parallel seat gates, venturi type	

*Vice President in Charge of Engineering, Walworth Co.

use, grouped according to these two classifications. It will be noted that the different groups are arranged from left to right in the order of their tendency toward obstruction of flow, and from top to bottom in the order of their tendency toward wearing, scoring, galling and seizing. With this in mind, the fact that none of the commonly used valve types are included in the lower right hand group, Class 3C, is both interesting and significant. This grouping of course is not absolute but represents general tendencies rather than actual performance of the various types of valves in service. For instance, the flow characteristics of a globe or angle valve can be improved by careful design and workmanship. Reduction can also be made in the tendency toward wearing, scoring, galling and seizing of valve seats by careful design and by the use of suitable valve seat metals, properly processed and surfaced.

Lubrication also reduces this latter tendency, and as far as this characteristic is concerned, lubricated plug valves in actual service might be raised from Class C to Class B, or A, depending, (1) on the efficiency of the lubricating system and the lubricant used, and (2), on the care taken in making sure that the valve is properly lubricated at all times. In this connection it must not be overlooked that the tendency toward erosion and wire drawing is least when the tendency toward wearing, scoring, galling and seizing is greatest, so that no matter what type of valve is used, it is necessary to nullify one or both of these undesirable tendencies, insofar as this is economically possible, by the application of skillful design, suitable materials and high grade workmanship.

General Features of Valves

Globe valves are usually mounted with the pressure entering under the disc, and for use in throttling or regulating flow they are more satisfactory than gate valves, which must be fully opened in order to realize their great advantage of straight way flow. A globe valve should also be used in preference to a gate valve when the service requires that the valve must be opened and closed frequently, because less turns of the handwheel are required to open it. This reduces the time required for operating the valve and also reduces the wear on the stem threads. A regrinding or renewable seat and disc type of globe valve is particularly well adapted to service of this character. Stem threads of ample proportion, having a long engagement in the bonnet when the valve is fully closed, are also desirable. For pipe lines discharging to the atmosphere and other places where a small leak would be particularly objectionable, two valves are often placed in the line in tandem. In operation No. 1 valve is always opened before No. 2 is opened, and closed after No. 2 is closed, thus protecting the seats of No. 1 valve from the erosive effect of wire drawing, and also from the tendency to gall.

If ample provision for expansion and other considerations will permit the use of a properly designed angle valve in place of a globe valve, a nipple and an elbow, considerable pressure drop will be saved, as well as extra pipe fittings and miscellaneous joints. When pressure drop is not an important factor globe valves are often used in preference to gate valves, particularly in the smaller sizes, because they are less expensive. Gate valves and globe valves of both the inside screw and outside screw types of construction are available on the market, but globe valves up to 2 in. in size are usually of the inside screw type. In general, the inside screw type valves are more compact and less expensive than the outside screw type. The stem threads, however, are exposed to the action of the fluid in the pipe line, and when high temperature, corrosion, incrustation, or abrasion are involved the outside screw type of valve has decided advantages even in the small sizes.

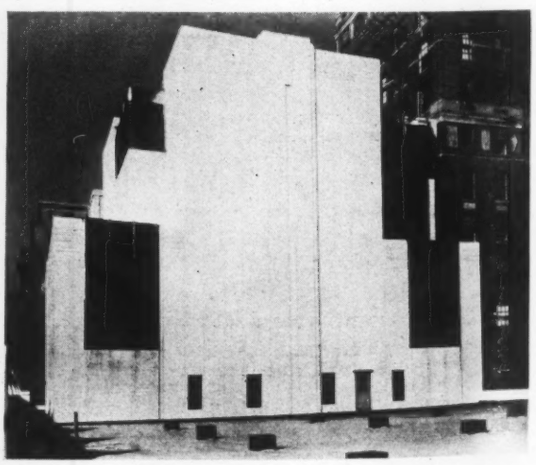
Screwed end valves are made in sizes from ⅛ to 12 in. and are extensively used in sizes from ⅛ in. to 3 in. Flanged end valves were seldom used in sizes below 2 in. until recently, but in severe service there seems to be a growing tendency toward the use of flanged valves in the smaller sizes. This fact was recognized in the first edition of American Standard B16e which established standard dimensions for 600 lb steel flanges for pipe sizes ranging from ½ to 24 in. inclusive, and now Sectional Committee B16 is extending the 1500 lb line to cover the same range of sizes.

[To be concluded]

Intake Louvers Are of Stainless Steel

AN example of the adaptability of stainless steel in air conditioning is its use for the penthouse louvers of the recently erected S. H. Kress & Co. building in New York City. At the top of the penthouse are the louvers to the outside air intake plenum chamber, while below are the intake louvers for the cooling tower fans.

The slats are made of 20 gage material, while the frames are formed of 16 gage stainless steel. The separate panels were shop fabricated by oxy-acetylene welding, and assembled by welding into complete units on the job. More than 8000 lb of stainless steel were required.



Four tons of stainless steel were required for air intake louvers in this penthouse atop a 10 story building in New York City

Simple Way to Analyze Performance of Compressor-Evaporator Combinations

By William Goodman*

PERFORMANCE of separate air conditioning compressors and coils can be computed easily, but once the two have been installed and connected by piping, the situation is different. The compressor and coil act as a single unit, and every change in the operating conditions of one will affect the other; the performance of the combination will depend upon their individual characteristics. It is our purpose here to show how the performance of combinations of given compressors and coils can be analyzed, and how the resulting refrigerating capacity and suction pressure of a system can be determined for various changes in operating conditions.

Why Compressor's Capacity Varies

The refrigerating capacity of a reciprocating compressor varies with the suction pressure against which it operates. At any one speed the higher the suction pressure, the higher will be the refrigerating capacity, as shown by Curve *A*, Fig. 1. Because of the greater density of the vapor at the higher suction pressures, the cylinder fills, during each stroke, with a weight of vapor which is larger than the weight filling the same cylinder volume at the lower pressures. The weight of vapor which will fill a cylinder at various suction pressures, and hence the refrigerating capacity at these pressures, can be computed.

Like compressors, the capacity of an evaporating or cooling coil also varies with the suction pressure because of the accompanying change in evaporating temperature. However, the capacity of a cooling coil *decreases* with rising suction pressures, as illustrated by Curve *B*, Fig. 1. At higher suction pressures, the temperature of the evaporating refrigerant is, of course, higher than at lower pressures. As a result, the temperature difference between the air surrounding the coil and the refrigerant inside of it decreases, causing a reduction in the capacity of the coil. The capacity of any given coil can be computed for various refrigerant temperatures.

If a compressor is selected for some given refrigerating capacity and suction temperature, an evaporator having the same capacity at the same suction temperature must also be chosen, but once the two have been connected they act as a unit, and a change in the conditions under which one of them is operating will affect the operating conditions of the other. Thus, a decrease in the speed of the compressor results in a decrease in its capacity. If the coil area could be reduced in proportion to the reduction in load, the suction pressure would remain unchanged. But if, as is often the case, the compressor is connected to a coil having a fixed surface area, the suction pressure will increase as the speed decreases because the cooling coil will continue for a short time to vaporize more refrigerant than the compressor can remove at the reduced speed. Because the compressor at the lower speed is unable to handle the larger weight of refrigerant, the suction temperature will gradually increase until eventually the capacity of the coil will be reduced to that of the compressor. Although the refrigerating capacity of the system will be reduced, the reduction will be less than it would have been if it were possible to maintain the suction pressure at the original point. Because of the effect of the coil, the suction pressure is increased and, hence, the capacity of the system is not reduced as much as it would have been had it been possible to decrease the coil area along with the compressor speed.

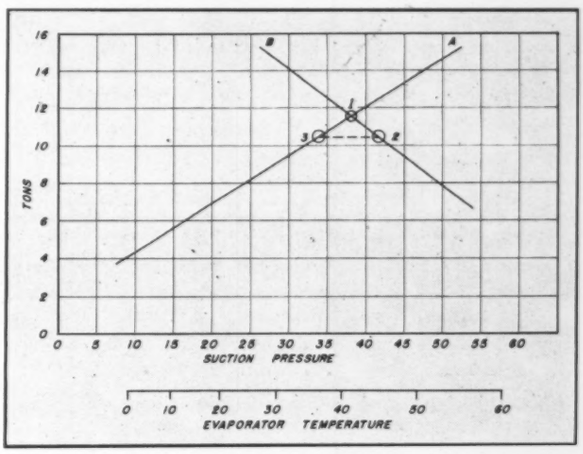


Fig. 1—Curve *A* shows how the refrigerating capacity of a reciprocating compressor increases with higher suction pressures, and Curve *B* how the capacity of a cooling coil decreases with rising suction pressures. All pressures shown are gage, and "Freon" is the refrigerant

Such changes are often difficult to visualize. Their effect on the operation of a cooling coil and compressor together is sometimes awkward to analyze. Various compensating factors offset changes due to other factors. Because of this, the following graphical method is not only quicker for such analyses but is often very illuminating.

Combining Characteristic Curves

Curve *A*, Fig. 1, represents the capacity of a compressor operating at a fixed speed, but against different suction pressures. Curve *B* represents the capacity of a given coil, for one entering air temperature and air velocity, but at different suction temperatures corresponding to the various suction pressures. If the coil

*The Trane Co. Member of Board of Consulting and Contributing Editors. Copyright, 1937, by William Goodman.

The graphic methods described here provide a means of analyzing the performance of air conditioning compressors and evaporators which are connected. The effect of variations of compressor speed, changes in the number of coils connected to a compressor, and changes in the temperature or volume of the air to be cooled can be readily analyzed. . . . The data for drawing the curves can usually be obtained from the catalogs of the various manufacturers. Even if the necessary data for drawing the curves are not always available, the methods described are still useful for quickly analyzing the general effect of various changes, as the curves representing the coil and compressor capacities can be sketched free-hand. Such sketches, while they will not give quantitative results, are valuable for quickly forecasting the effect of various changes—changes whose effect might otherwise be rather difficult to visualize

and compressor of Fig. 1 are connected, what will be the capacity and at what suction temperature will the combination operate? The answer is found at Point 1, where the curves intersect; this must be true since the refrigerating capacity of a system depends only upon the weight of refrigerant vaporized. When the suction pressure of a system becomes steady at one point, the weight of refrigerant removed by the compressor is equal to the weight vaporized in the coil. Hence, the refrigerating capacity of the interconnected coil and compressor will be the same.

The selection of Point 1 as the point representing the suction pressure and capacity of the system implies that the pressure in the evaporator and at the compressor is the same. Actually, due to friction in the connecting piping, the pressure in the evaporator is higher than at the compressor. If the pressure drop is known, a horizontal line can be drawn between Points 2 and 3; the length of the line represents the known pressure drop and Points 3 and 2 the pressures at the compressor and evaporator, respectively. Regardless of this pressure drop, the weight of vapor circulated by the compressor must still be equal to the weight evaporated in the coil, when steady conditions are attained.

Although the length of Line 2-3 has been exaggerated for clarity, it does show clearly the effect of friction losses on a compressor and evaporator which have been selected to operate at Point 1. The capacity of the system will be reduced because the pressure at the compressor will be reduced while the pressure and, hence, the temperature at the evaporator will be increased. Usually, with suction piping which has been correctly designed and installed, the pressure drop will be small and, hence, its effect on the capacity of the system will be negligible. Although this is not always the case, in the illustrations which follow, the effect of pressure drop in the suction piping will be ignored for the sake of simplicity and clarity of presentation. When its effect is to be taken into account, the method just described can be applied easily.

Varying Entering Air Conditions

Variation in the capacity and suction temperature of a system when the dry and wet bulb temperatures of the air entering a coil change is of interest in the design of air conditioning systems. Curve *B*, Fig. 1, has been drawn for one entering air condition—that is, for one combination of dry and wet bulb temperature. A different coil characteristic curve must be drawn for each entering air condition. Thus, in Fig. 2, two coil characteristic curves are shown for two different entering air conditions. Curve *B*, Fig. 2, is the same as in Fig. 1. Curve *C* represents the characteristics of the same coil for a lower entering air condition. Both curves have been drawn for the same coil and the same air velocity, but for different entering air conditions. The capacity of the system and the suction temperature at which it will operate for each of the two entering air conditions can be read at Points 1 and 2.

So far, we have dealt only with a compressor operating at a fixed speed. If the speed is reduced, a new curve must be drawn, because its capacity is reduced. For example, Curve *A*, Fig. 2, represents the capacity of a given compressor when operating at full speed. If the speed is reduced to one-half, its characteristic curve would be represented by Curve *D*, Fig. 2.

The data for compressor curves at various speeds can be computed if the characteristic curve at one speed is

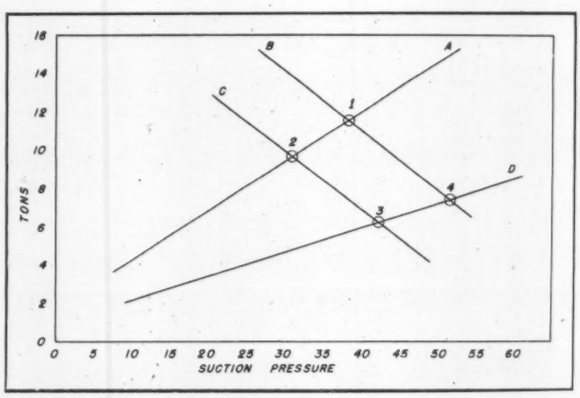


Fig. 2—A different coil characteristic curve must be drawn for each entering air condition. Curve *B* is the same as Curve *B* in Fig. 1, and Curve *C* represents coil characteristics for a lower entering air condition. Curve *A* is for the compressor operating at full speed, and Curve *D* for half speed

known. At the same suction pressure, the capacity varies directly with the speed. Thus, for the same suction pressure, the capacity of all points on Curve *D* is one-half of the capacity of all points on *A*. The capacity of the system, and the suction pressure at which it would operate with the lower compressor speed can be read at Points 3 and 4 for the different entering air conditions.

The capacity of a cooling coil varies not only with the entering air condition, but also with the velocity of the air flowing through it. If the air quantity through a coil is changed, its velocity is also changed. For the same entering air condition, a reduction in air velocity will reduce the capacity of the coil. Therefore, the coil characteristic curve drawn to the left of Curve *B*, Fig. 2, can represent the capacity of a coil not only for a lower entering air condition, but also for a lower air velocity. A reduction in either the entering air condition, the air velocity, or a reduction in both will move the coil characteristic curve to the left, as in Fig. 2. When the air

velocity changes, the slope of the coil characteristic curve changes slightly.

Two Separate Coils Connected to One Compressor

Often two or more separate cooling coils of different capacities are connected to one compressor. Thus in Fig. 3, Curve *C* represents the characteristic of one large coil and Curve *D* that of a smaller coil. It does not matter whether the entering air condition and the air velocity are the same for both coils, as the method is applicable in either case.

It is obvious that when the system of Fig. 3 is operating at any one steady suction pressure, the load on the compressor is equal to the sum of the separate loads on the two coils. Hence, the capacity of the coils at any suction pressure can be represented by Curve *B*. This curve has been drawn by adding the capacities of the two coils at the same suction pressure. This addition (graphical or arithmetical) is performed at several different suction pressures enabling Curve *B* to be plotted. If the compressor capacity at full speed is represented by Curve *A*, it is evident that the capacity of the system when both coils are operating will be represented by Point 1. Also, under these conditions, the suction pressure and the capacity of the individual coils will be represented by Points 4 and 5. However, if Coil *C* is valved off, while only Coil *D* is operating, capacity of the system and the suction pressure at which it will operate will be represented by Point 3. On the other hand, if Coil *D* is valved off, while Coil *C* alone is operating, the system capacity can be read at Point 2.

When choosing two coils for any desired total capacity, they must, of course, be selected at Points 4 and 5. It

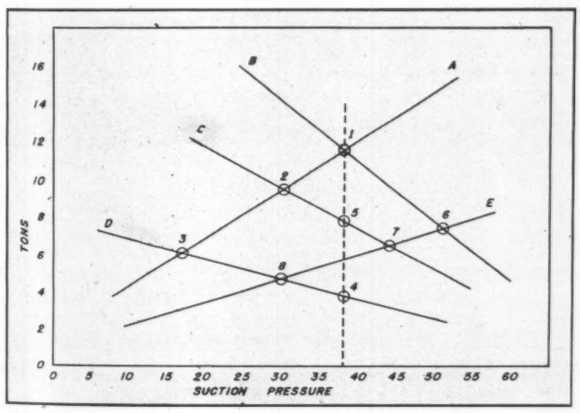


Fig. 3—Curves for two coils connected to a single compressor, that marked *C* representing a large coil and *D* a smaller coil. *B* is the total of *C* and *D*

is apparent from Fig. 3, however, that the capacity of the *individual* coils when operating alone will be increased because of the drop in suction temperature.

If a two speed compressor is used, and the low speed is half the full speed, the low speed curve for the compressor will be represented by *E*, Fig. 3. If instead of one large compressor, two smaller compressors were used, each having half the total capacity of the single large compressor, Curves *A* and *E* would still represent the capacity of the compressors; Curve *A* would represent both the smaller compressors operating together, while Curve *E* would represent either one of them operating alone.

The capacity of the system when operating one large compressor at half speed, or running one of the smaller compressors alone, would be represented by Points 6, 7, and 8 depending upon which of the single coils, or both, were operating. Points 7 and 8 would represent the capacity with the individual coils operating alone. If the smaller compressors were not of equal size, it would be necessary to plot their capacity curves separately and add them to find the total capacity curve. The operating point for either compressor with either coil could then be found as outlined above.

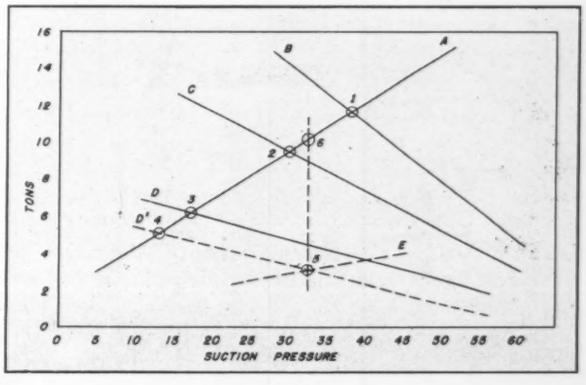
Reducing Compressor Speed to Prevent Frosting

When two coils are connected to one compressor, and one coil is shut off, it is evident that the suction pressure of the system will fall if the compressor capacity is not changed. Often the suction pressure may fall to the point where the coil will frost, which is undesirable if forced air coils are used. Frosting can be prevented either by reducing the speed of a single compressor, stopping one compressor if two are installed, or by a back pressure valve (discussed later). If the compressor capacity is to be reduced, the speed at which the compressor should operate if frosting is to be avoided can be computed.

Suppose that Curves *C* and *D*, Fig. 4, represent the individual capacities of two coils when the entering air conditions and air velocities are a maximum. Curve *B* represents their total. Now suppose that Curve *D'* represents the individual capacity of the smallest coil when the entering air conditions are a minimum. Curve *A* represents the capacity of the compressor when running at full speed.

It is apparent from Fig. 4 that the lowest suction temperatures will occur when only Coil *D* is connected to the compressor and when the entering air conditions are such that the coil capacity is represented by Curve *D'*. If the coil is to be prevented from frosting, the refrigerant temperature should not be allowed to go much below 32 deg. Therefore, spot Point 5 on Curve *D'* at a refrigerant temperature of, say, 33 deg to provide a slight margin of

Fig. 4—In this sketch, *A* represents the compressor at full speed, *B* the total of *C* and *D* (which represent the individual capacities of two coils when the entering air conditions are maximum), and *D'* the individual capacity of the smaller coil when the entering air conditions are minimum



safety. The refrigerating capacity of the compressor should be three tons at the suction pressure corresponding to 33 deg as read at Point 5. The capacity of the compressor when running at full speed at this same suction pressure would be 10 tons, as read at 6. If a single compressor having two speeds is used, its lower speed should be 3/10 or 30 per cent, of the full compressor speed if frosting is to be avoided. Curve *E* is the compressor characteristic at 30 per cent of full speed.

Use of Back Pressure Valves

A back pressure valve is a valve which automatically maintains the pressure in an evaporator at any constant point for which it is adjusted; it does this regardless of changes in compressor capacity. It should be clearly understood that with such a valve the pressure at the compressor varies while the pressure in the evaporator is held constant. This valve, which can be installed anywhere in the suction line, simply throttles the refrigerant vapor from the higher pressure being maintained in the cooling coil to the lower pressure being maintained in the portion of the suction line between the valve and the compressor. Its action is similar to that of a steam pressure reducing valve, except that instead of being controlled by the low pressure, it is controlled by and maintains the high pressure side at a constant point.

Referring to Fig. 5, the vertical dotted line represents the constant suction pressure which the valve is adjusted to maintain in the evaporator. Curves *C* and *D* show the capacities of two separate evaporators, while Curve *B* represents their total capacity. Curve *A* represents the capacity of the constant speed compressor to which both coils are connected. When both coils are operating

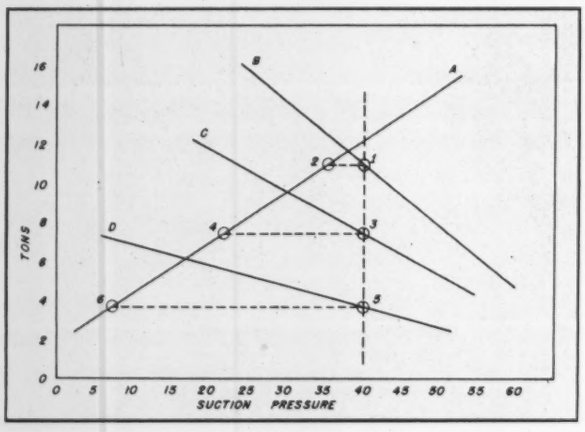


Fig. 5—The vertical dotted line represents the constant suction pressure which a back pressure valve maintains in the evaporator. *A* represents the compressor characteristics, *B* the total capacity of the two coils, and *C* and *D* the individual capacities of the coils

the back pressure valve is wide open. The pressure at the coils and the pressure at the compressor are represented by Points 1 and 2, respectively. The length of Line 1-2 represents the total pressure drop through the suction line and the wide open valve. If Coil *D* is valved off, and only Coil *C* remains connected, the valve will throttle and maintain a constant pressure in the evaporator.

The capacity of the system will be represented by the horizontal line through Point 3, at the intersection of Curve *C* and the vertical dotted line representing the constant pressure in the coil. The suction pressure at the compressor will be represented by Point 4, as the tonnage of the compressor and coil must always be the same under steady operating conditions. The length of Line 3-4 represents the drop in pressure through the throttling valve. Similarly, Point 6 represents the suction pressure at the compressor when only Coil *D* is operating. Line 5-6 represents the pressure drop through

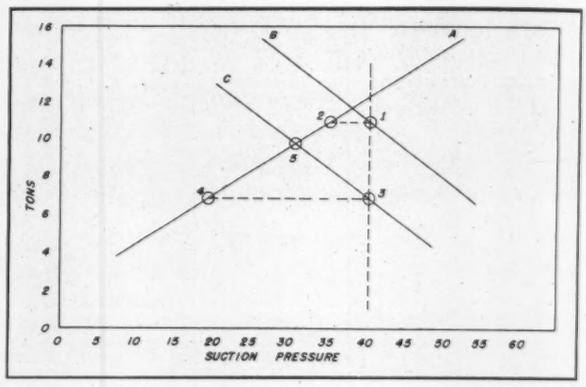


Fig. 6—Characteristic curves for single compressor and single coil, with back pressure valve, with various entering air conditions

the valve under these conditions. Note that with either coil operating alone, or with both coils operating together, the evaporating pressure inside the coil would be the same, but the pressure at the compressor and the refrigerating capacity would be different in all three cases.

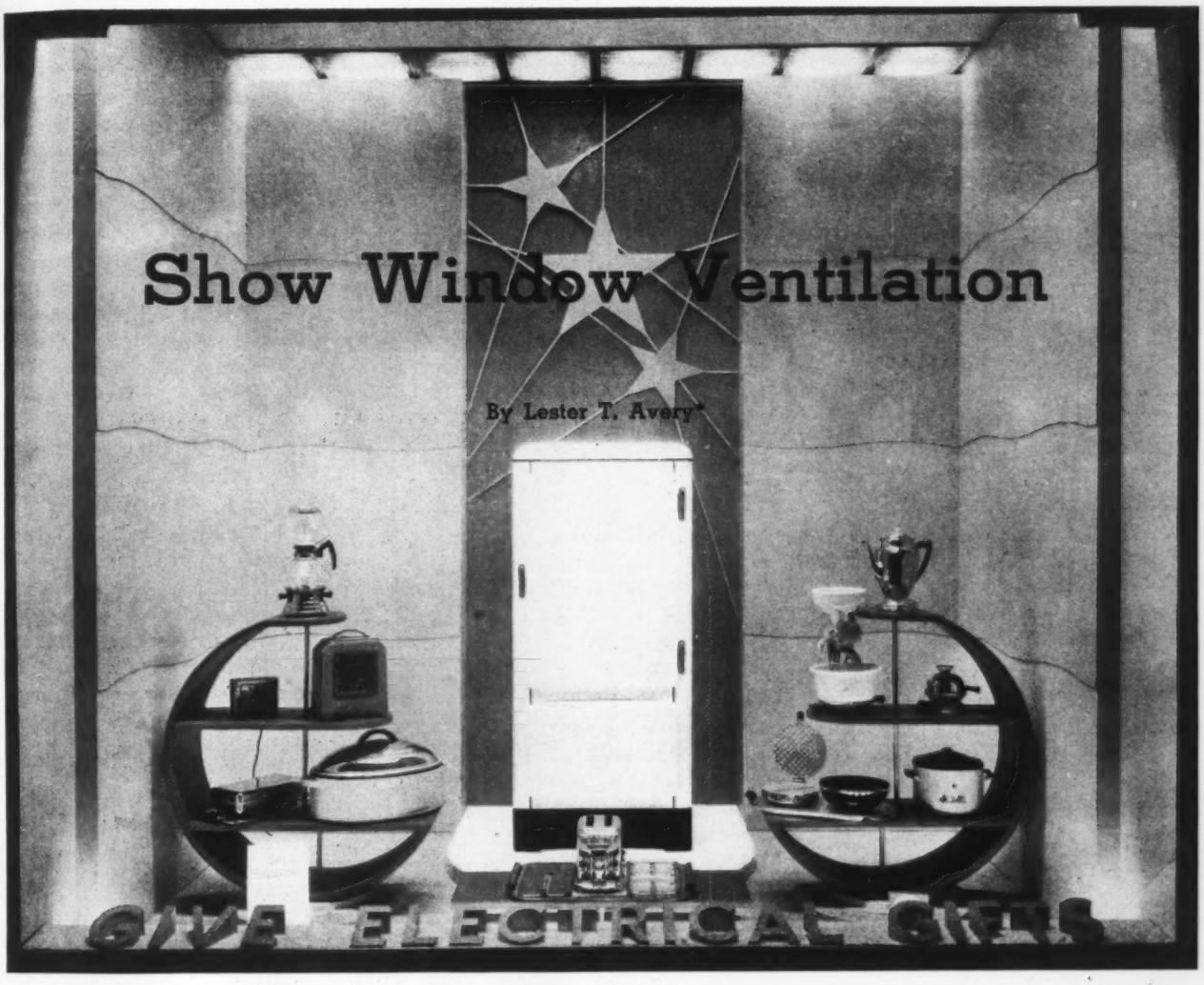
When a single coil is connected to a compressor and a back pressure valve is installed in the suction line, the diagram representing the capacity of the system with various entering air conditions is shown in Fig. 6, which is similar to Fig. 5, the only change being in the slope of the coil capacity lines.

It is apparent from Fig. 6 that the change in the capacity of a system with the different entering air temperatures is much more rapid when a back pressure valve is used. Because the evaporating temperature inside the coil is held constant, the refrigerating capacity of the coil will vary directly with the temperature of the entering air for any one velocity. On the other hand, if no valve were used, the suction temperature would drop along with the temperature of the entering air and the refrigerating capacity of the coil would be greater because of the greater temperature difference. In other words, for the entering air condition represented by *C*, Fig. 6, Point 5 shows the capacity without a valve. With a valve, the capacity is reduced to Point 4. This is an important characteristic which must be borne in mind when using these valves. The air conditioning loads at reduced entering air temperatures should be checked to make sure that the capacity will still be adequate.

When the refrigerant vapor is throttled while flowing through a back pressure valve, it is superheated and its volume increases. Because of this the compressor Curves *A* of Figs. 5 and 6 would drop slightly faster than shown, at the lower suction pressures. However, the correction is negligible and may safely be neglected insofar as these graphical analyses are concerned.

Show Window Ventilation

By Lester T. Avery*



SHOW windows need ventilation for three important reasons: (1) To keep the temperature down within reasonable limits. (2) To prevent condensation on the glass in cold weather. (3) To keep out dirt.

Show window temperatures become excessively high with heavy flood lighting, temperatures as high as 150 F having been noted; in the direct rays of the light even higher temperatures occur. This has a bad effect on goods on display—electric motors, watches, refrigerators, and even dress goods can be seriously injured by "cooking" at these temperatures. Oil and grease will run out of bearings, watches will dry out and have to be completely overhauled, asphalt or any binder material used in cabinet construction will melt out. It goes without saying that any food products, such as displays for restaurants or grocery stores, cannot be exposed to excessively high temperatures. Such windows are generally refrigerated, which is a separate problem. We are dealing here with cooling by ordinary ventilation only.

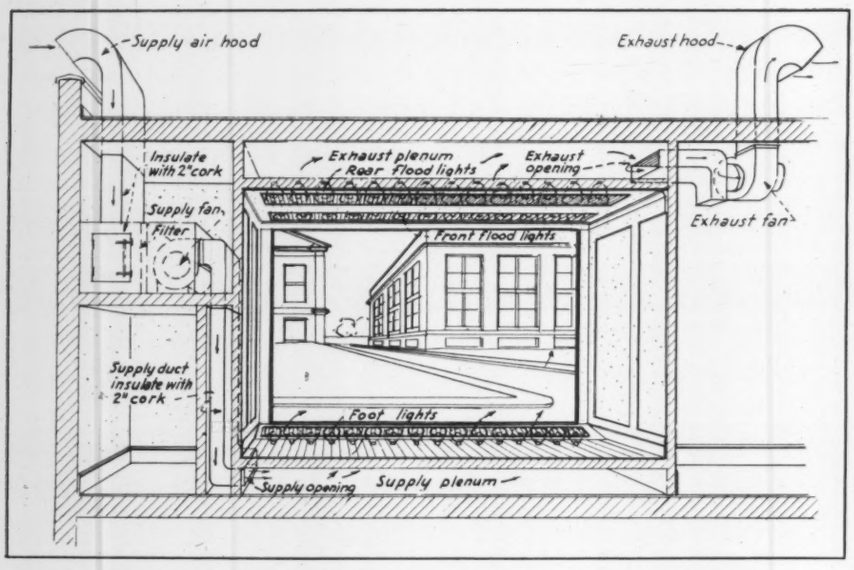
It is well known that condensation will appear on windows if the glass temperature drops below the dew point of the inside air. Single glass varies in temperature according to the temperature difference between inside and outside, and it is common to have condensation on show windows at outside temperatures below 20 F. If the store is humidified, or if it is a vegetable or grocery store where high humidities occur, then condensation is a serious problem. In specialty shops where there may be crowds on sales days, the moisture given off by the people will raise the relative humidity so that the window may fog.

Dirt is certainly not desirable on displayed merchandise and all show windows leak a certain amount around the cracks, to say nothing of the ordinary dirt that settles out of the air.

The isometric diagram shows a ventilating system applied to the east and west show windows of the Cleveland Electric Illuminating Co. Each window is 10 ft long, 8 ft deep, and 10 ft, 6 in. inside height. There is an 18 in. plenum space below the floor of the window to accommodate the lower flood lights, and an 18 in. plenum space above the show windows for the ceiling lights. The lighting consists of a front row in the floor containing eleven 200 watt lights, a front row in the ceiling of eight 500 watt lights, and a rear ceiling row of eight 300 watt lights. The lighting provides uniform intensity without shadows in any part of the show window. The illumination averages 800 foot-candles from the floor up to the 4 ft level, with a somewhat higher rating as the height approaches the direct rays of the flood lights in the ceiling. There is a total of 8.6 kw of lighting in each window.

In a paper presented to the A. S. H. V. E., Walter Sturrock pointed out that only 15 per cent of the heat

*President, Avery Engrg. Co.



View looking from inside the window showing method of ventilating

from lights can be considered sensible heat, which can be removed directly from a trough acting as a trap for this heat. The balance of the energy, 85 per cent, is radiant heat which passes into the lighted space directly with the light rays. From this it is obvious that any ventilation to remove heat must treat the space lighted as well as the troughs and plenum spaces used for the flood lighting fixtures.

The lighting load of 8.6 kw will produce approximately 29,300 Btu per hr, as 1 kw = 56.92 Btu per minute. The volume of the space is 840 cu ft and it did not seem practical to try to handle much greater than one air change a minute as there would be too high an air motion which would disturb any materials such as drapes. Accordingly, the supply fan was designed to handle 1000 cfm, and this air is conducted to the plenum space below the window and allowed to come up through the openings between the flood lights in front. The supply fan takes its suction from a mezzanine roof, and the opening is protected with screens to keep out insects. A double bank of throw-away filters is used to remove the dirt.

The ceiling lights total 6.4 kw, of which 85 per cent is transmitted as heat into the show window proper, and all of the floor lights, 2.2 kw, enter the window as heat. This is about 26,000 Btu per hr, or 434 Btu per minute. There is some heat lost through the window and the walls of the show window, and 1000 cfm would warm about 20 F in ordinary weather. This is not excessive even in hot summer weather as the increased air quantity by running the exhaust fan, and the stratification of the air by drifting supply upwards through the window, provides sufficient cooling effect so that the window temperature never rises above 100 F. This warming of the air also is sufficient in the winter to prevent too cold temperatures. In very cold weather the supply fan can be stopped if necessary, but there seems to be enough pick up of heat through the supply duct system fan, and the plenum so that temperatures never drop below 50 F even with zero outside.

Under fairly cool outside weather conditions, the show window itself gives up a great deal of heat through the glass, so the exhaust fan was planned to operate only in case of extraordinarily high temperatures. The exhaust fan was sized for 800 cfm to be sure that there would always be a pressure on the window cracks to prevent infiltration of dirt. A thermostat in the upper plenum space starts the exhaust fan at 100 F. This has a tendency to increase the supply fan air quantity, but the stack effect from the exhaust duct connection provides a continuous vent for the window whether the exhaust fan is running or not. The supply duct is insulated with 2 in. of cork to prevent condensation.

The results with this arrangement have been entirely satisfactory. The air distribution is fairly uniform throughout the entire window and temperatures from 80 to 90 F are satisfactory for the display ordinarily used. There is no disturbing current of air and the filter keeps out most of the dirt. Displays are left in place a full week, at the end of which time they are still fairly clean.

The supply fan is shut off when the window flood lights are turned off. The exhaust fan is permitted to operate automatically at all times.

The important feature of this ventilation system is the use of outside air for ventilation. The customer's room, which is back of this show window, is completely conditioned, winter and summer, with an air washer system which keeps the humidity at the desired point. If any of this air gets into the show window it will cause condensation on the glass in cold weather. By using outside air it is obvious that the dew point of this air will always be below the dew point of the glass. Even in cold, foggy weather, when the supply fan is taking practically saturated air, there can be no condensation as the air changes rapidly enough so that any quick drop in outside temperature must immediately drop the dew point of that air.

Too many displays in show windows are spoiled by dirt, window condensation and high temperatures. By using a supply and exhaust system as described, the ventilation engineer can produce uniformly good results for any type or size of window, despite the high lighting intensities now so widely used.

The important part of the scheme of show window ventilation described here is the use of outside air, which prevents having air inside the window at a high dew point that would cause condensation on the glass, no matter how cold it gets. When air from a humidified store or a store where there is a great deal of moisture from people or displays is used for window ventilation, condensation on the window is apt to occur. . . . Both a supply and an exhaust fan are used in the method illustrated for economical temperature control, and the air is filtered to keep dust and dirt from spoiling the merchandise on display

Heating·Piping
and Air Conditioning

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

JOURNAL SECTION

CONTENTS • DECEMBER, 1937

Study of Methods of Control and Types of Registers as Affecting Temperature Variations in the Research Residence, by A. P. Kratz and S. Konzo 745

The Inspiration of Society Membership 757

Summer Cooling Requirements of 275 Workers in an Air Conditioned Office, by A. B. Newton, F. C. Houghten, Carl Gutberlet and R. W. Qualley 758

A.S.H.V.E. Research—A Page of News Notes and Comment, by Brewster S. Beach 767

Correlating Thermal Research 769

New York Prepares for January Meeting 770

Nominations for 1938 772

News of Local Chapters 773

Candidates for Membership 777

Candidates Elected 780

Heating · Piping and Air Conditioning
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Study of Methods of Control and Types of Registers as Affecting Temperature Variations in the Research Residence

By A. P. Kratz* and S. Konzo** (*MEMBERS*)
Urbana, Ill.

Introduction

Preliminary Statement

IT was observed in the Warm Air Research Residence during the extremely severe winter heating season of 1935-1936, which was characterized by prolonged periods of cold weather, that although the air temperature at the breathing level was maintained at approximately 72 F for all weather conditions, a certain amount of discomfort was experienced in some of the first story rooms, particularly when the outdoor air temperature was lower than approximately 15 F. This condition was especially noticeable during the off-periods of the fan in the forced-air heating system.

The object of this investigation, therefore, was to study under actual service conditions, some of the factors which affect the cyclical variations in temperature accompanying the operation of a forced-air heating system; and some of the factors which affect the temperature difference between the breathing level and the floor level. In addition, tests were made to determine the performance characteristics of a two-speed fan used in connection with a forced-air heating system.

The studies of the factors affecting the temperature difference between floor and breathing level have been in progress for several years in the Research Residence and have been confined to gravity warm-air, auxiliary or *booster* fan, and forced-air heating systems. These studies were supplemented with tests conducted during the winter of 1935-1936 on the forced-air heating system to determine the factors affecting the cyclical variations in room air temperatures, and with tests conducted during the winter of 1936-1937 on the two-speed fan.

Description of Research Residence

The Research Residence in Urbana, Ill., and the heating plant have been completely described in a previous publication.[1] The Residence is a three-story structure of standard frame construction, in which the walls are not insulated, and no weatherstripping is used at the windows nor at the doors. With the exception of one season, it has not been equipped with storm sash.

The total space heated during these tests consisted of three rooms, a sun room, a breakfast nook, and a hallway on the first story; three rooms, a bathroom, and a hallway on the second story; and two rooms, a bathroom, and a hallway on the third story. The total volume of this heated space, from which the basement was excluded, was approximately 17,540 cu ft. The calculated heat loss was approximately 159,000 Btu per hour at an indoor-outdoor temperature difference of 80 F. The Residence is completely furnished, and during the heating season it was occupied by four people.

The heating plant consisted of a warm-air furnace used in connection with a forced-air heating system. Three cold-air returns were used which were connected into a cold-air box above the inlet to a centrifugal type of fan. The furnace was placed at the East end of the basement, and the warm-air registers were served from two main trunk systems. A more detailed description of the furnace plant, fans, and automatic controls which were used in the different tests has been included in the sections relating to the tests.

Description of Plant

During the heating seasons of 1935-1936 and 1936-1937 the furnace was of steel construction[2] specially designed for oil combustion, and was equipped with a gun-type oil burner having an oil input rate of 13 lb per hour. The centrifugal type fan, which was enclosed within the furnace casing, was equipped with forward curved blades placed on a wheel 15.5 in. in diameter. The fan was driven from the electric motor by a V-belt connection.

The control[3] of the heating plant was accomplished by means of a room thermostat operating to start and stop the combustion process and the circulating fan as shown in Fig. 1. This room thermostat was used in conjunction with two bonnet thermostats which served as high and low limit controls for the temperature of the air in the furnace bonnet. The room thermostat, which was of the heat-anticipating type, was located on an inside wall of the dining room at a height of 30-in. from the floor and was adjusted to maintain an average air temperature of approximately 72 F at the 60-in level in all of the rooms of the Residence.

Factors Affecting Temperature Variation

Method of Conducting Tests

These series of tests comprised part of the routine test program conducted at the Research Residence. The air

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**Special Research Assistant Professor, Engineering Experiment Station, University of Illinois.

[1]University of Illinois, *Engineering Experiment Station Bulletin* No. 266, pp. 11-17, by A. P. Kratz and S. Konzo.

For presentation at the 44th Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, New York, N. Y., January, 1938.

[2]Performance of Oil-Fired, Warm Air Furnaces in the Research Residence, by A. P. Kratz and S. Konzo. (A.S.H.V.E. JOURNAL SECTION, *Heating, Piping and Air Conditioning*, December, 1936, pp. 693-704).

[3]Control Type IV described in the paper, Automatic Controls for Forced-Air Heating Systems, by S. Konzo and A. F. Hubbard (A.S.H.V.E. TRANSACTIONS, Vol. 40, 1934, pp. 37-54).

temperatures in all of the rooms of the house at the 60-in. level were maintained at approximately 72 F during all of the 24 hours which constituted one test period. Either periodic or continuous records were made of all significant temperatures in the rooms, in the duct system, and of the outdoor air, as is completely described in previous publications.[4]

Special observations were also made of the air temperatures in the four corners of the living room by means of thermometers placed 4-in. above the floor and 60-in.

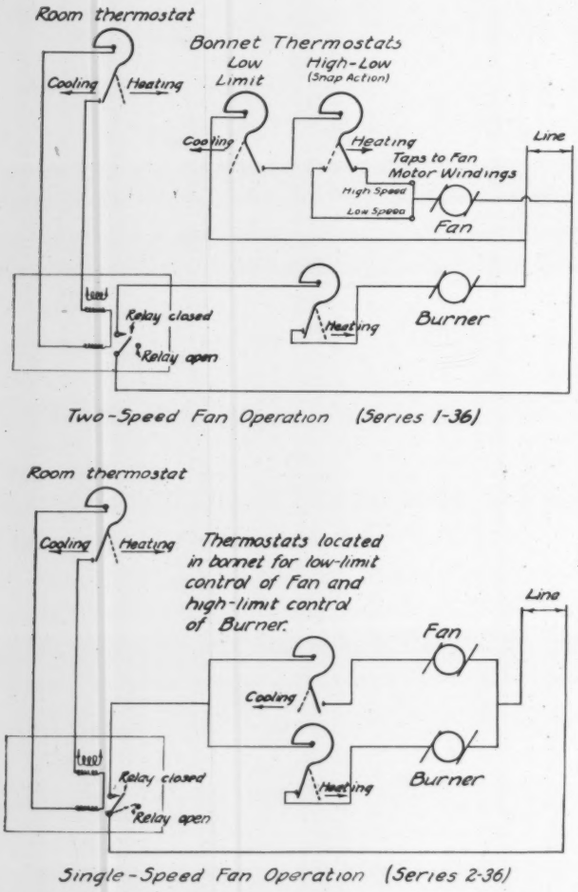

Fig. 1—Simplified wiring diagrams for two methods of control

above the floor at a distance of approximately 32-in. from the adjacent walls. Thermocouples were also located in the middle of the living room at elevations of 4-in. above the floor, 60-in. above the floor, and 4-in. below the ceiling. These thermocouples were used to obtain records of the variations in air temperatures at each of the three levels in this room, and were found to be more sensitive to slight changes in temperature than glass thermometers placed adjacent to them.

Results of Tests

A typical record of room air temperatures, at the floor level, breathing level, and ceiling level, during a complete cycle of the on-period and off-period of fan operation is shown in Fig. 2 for a day in which the outdoor air temperature was —8 F. This record was obtained when the fan was operated with the arrangement of thermostats shown in the lower half of Fig. 1. It may be observed that during the entire cycle of temperature variation, the air at the ceiling level was warmer than that nearer the floor level. Furthermore, when the fan operation ceased, the temperature of the air near the ceiling decreased more rapidly than did the temperature of the air near the floor.

From the standpoint of maintaining a minimum heat loss from the exposed walls in the upper portion of the room, a low temperature at the ceiling level would prove desirable. However, from the standpoint of its relation to the comfort conditions of the occupant, the temperature at the ceiling level is of very little significance. From the latter consideration, it would appear that the average of the temperatures at the floor and breathing level should be used as a criterion of the comfort conditions in the living zone. This average value, which has been designated as the *living zone* temperature, together with the relative humidity of the air in the living zone, determines the effective temperature maintained in that zone. Since a value of 63 F effective temperature has been established[5] as the minimum for comfort for persons normally clothed and surrounded by walls at the same temperature as that of the room air, this value has been used as a standard for comparison in evaluating the comfort conditions maintained in the room with various methods of operation of the heating plant.

The cyclical variation in living zone temperatures in the southwest bedroom, as indicated in part (a) of Fig. 3, was very small. Furthermore, since the effective temperature in the living zone was greater than 63 deg at all times, the temperature conditions in the room may be regarded as highly satisfactory. This small variation in living zone temperature was characteristic of the conditions which were maintained in all of the rooms on the second and third stories of the Research Residence, as is indicated by the values listed in Table 1.

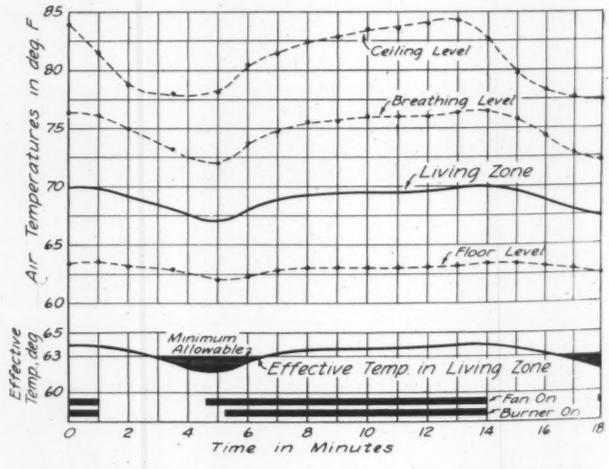

Fig. 2—Typical temperatures of living room, Test 1003, outdoor = —8 F

On the other hand, the variation in the living zone temperature for rooms on the first story was comparatively large, it being approximately three times that of the rooms on the second and third stories. This

[4]University of Illinois, *Engineering Experiment Station Bulletin* No. 266, by A. P. Kratz and S. Konzo; Investigation of Warm-Air Furnaces and Heating Systems, Part VI., April 10, 1934.

[5]Comfort chart of the American Society of Heating and Ventilating Engineers (A.S.H.V.E. Guide, 1937, page 68, Fig. 6).

difference in the temperature variations between first story rooms and rooms on the second and third stories resulted from the *gravity* action accompanying the intermittent operation of the fan. The anemometer readings obtained at the face of the warm air registers indicated that during the off-periods of the fan practically no gravity circulation occurred in the ducts to the first story rooms. Hence, heated air was delivered to the rooms intermittently, and only during periods of fan operation. On the other hand, very marked gravity circulation occurred in the ducts to the second and third stories, the amount of air delivered being determined by the resistance to gravity flow of the particular ducts. Heated air, therefore, was being delivered to these rooms continuously, although in varying amounts.

The variation in living zone temperature in the living room was also representative of the conditions existing in the kitchen and hallway on the first story, and is illustrated by the curves shown in part (b) of Fig. 3. It may be noted from the shaded section in the curve for effective temperatures, that approximately 2 min after the circulating fan was stopped the effective temperature in the living zone was reduced to less than 63 deg. The comfort conditions cannot, therefore, be regarded as entirely satisfactory, although either a slight increase in the average living zone temperature or a more frequent cyclical operation of the fan would be sufficient to provide satisfactory operation at all times.

The temperature conditions maintained in the sun room, as indicated by the curves shown in part (c) of Fig. 3 were not satisfactory, since the effective temperature in the living zone did not attain a value of 63 deg at any time. The variation of 3.8 F in the living zone temperature of the sun room was larger than that in any other room in the house, although it was only slightly larger than that of the adjacent dining room, which was affected to some extent by the temperatures in the sun room.

The conditions obtained in the sun room during extremely cold weather and with intermittent operation of the fan are to some extent representative of the problems encountered in the case of the isolated room under similar conditions of operation. In the first place, the sun room was exposed to the outdoors on three sides and the roof, and the floor was exposed to an unheated, unexcavated space. Furthermore, the room was equipped with 125 sq ft of single-pane window surface and had a heat loss of 30,050 Btu per hour, based on an 80 F temperature

Table 1—Change in Living Zone Temperature During On-Periods and Off-Periods of Fan[a]

(Difference between maximum and minimum values)

Story	Room	Change in Temperature, F	Average for Story, F
First	Sun Room	3.8	
	Dining Room	3.5	
	Hall	2.0	
	Living Room	2.2	
	Kitchen	1.8	2.7
Second	E. Bedroom	0.2	
	S. W. Bedroom	0.9	
	N. W. Bedroom	1.5	
	Bath	0.7	0.8
Third	W. Dormitory	1.1	
	E. Dormitory	0.5	0.8

[a] Temperature of living zone determined by average of air temperatures at levels 4 in. and 60 in. above floor.
Test made on February 18, 1936. Test No. 1003. Series 1-35 Controls. Outdoor temperature during test period approximately —6 F.

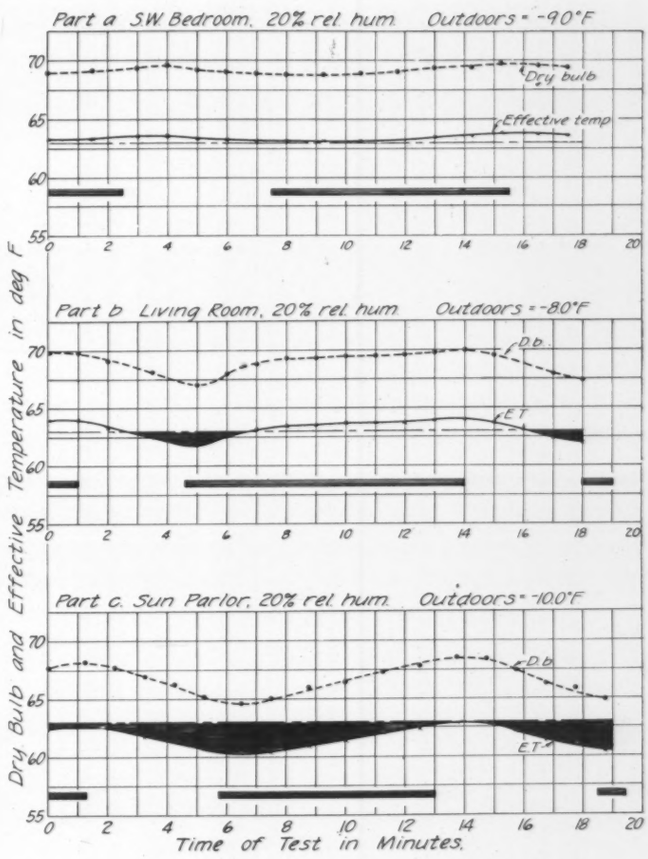
Part a SW Bedroom, 20% rel. hum. Outdoors = -90°F
Dry bulb
Effective temp
Part b Living Room, 20% rel. hum. Outdoors = -80°F
D.B.
E.T.
Part c. Sun Parlor, 20% rel. hum. Outdoors = -100°F
D.B.
E.T.
Dry Bulb and Effective Temperature in deg F
Time of Test in Minutes.

Fig. 3—Variation in temperatures of living zone in three rooms, Test 1003

difference. Since the volume of the room was 1,150 cubic feet, the heat loss per cubic foot of internal volume was 26.1 Btu, or approximately 2½ to 4 times that of any other room in the house. It is not surprising, therefore, that the temperature differential from the breathing level to the floor was extremely large in cold weather, resulting in a living zone temperature that was below the minimum required for comfort, even when the plant was in operation. In addition, when the fan was stopped, the sun room, due to the extremely large heat losses, tended to cool much faster than did the other rooms in the house.

The conditions which contribute towards discomfort can be alleviated, corrected, or avoided entirely by modifications in operation of the plant and by the reduction of the heat losses from the room. The following corrective measures may be suggested:

(a) In the case of an isolated room, or a room having excessive heat losses, it is important that the losses be minimized by means of weatherstripping, storm sash, sidewall insulation, ceiling insulation, or floor insulation. Such improvements in house construction not only tend to reduce the cooling rate of the room when the fan is stopped, but also tend to decrease the temperature differential from ceiling to floor.

(b) In many cases in which the exposure of different rooms is unequal it is common practice to use zone controls.

(c) It is good practice to provide in the original design of the plant for the maintenance of slightly higher air temperatures in isolated rooms, so that the average air temperature during a complete cycle of operation will be increased.

(d) Any method of operation or any device which will tend to reduce the temperature differential from breathing level to

floor is particularly desirable. In fact it may be noted that with the maintenance of a uniform breathing level temperature in all the rooms of the house, any differences in the comfort conditions in the different rooms result largely from differences in the temperature gradients maintained in the rooms.

(e) The conditions of discomfort arising from the off-periods of the fan can probably be minimized by providing for greater duration of fan operation. There is some tendency in commercial practice, particularly in the case of large installations, to use continuous fan operation. In this connection it is probable that the most ideal conditions of comfort will be attained when both the fan and the burner tend to operate continuously.

(f) In the case of intermittent fan operation some improvement in conditions may be obtained by more frequent operation of the fan in order to reduce the length of each cooling period.

In this discussion some methods of operation suggested by items *d*, *e*, and *f* have been investigated, since the suggestions in items *a*, *b*, and *c* seemed to be more or less self-evident without necessity for proof.

Effect of Method of Control on Temperature Variation

Method of Conducting Tests

A preliminary series of tests was run to determine the effect of four different methods of control on the temperature variations obtained in the living zone of the living room. All observations were made when the outdoor temperature was between —2 F and +4 F, since the conditions of discomfort were noticeable only in very cold weather and were not of any consequence in average winter weather.

Results of Tests

With normal intermittent operation of the fan it was observed that during zero weather the fan operated 4.6 times per hour, and the maximum variation in the living zone temperature was 2.7 F. No observable difference in either item was obtained when the room thermostat, which was of the heat-anticipating type, was lowered from the 60-in. level to the 30-in. level on the inside wall of the dining room.

When the same room thermostat was located at the 60-in. level on the inside wall of the sun room the frequency of fan operation was increased to 5.2 times per hour, with an accompanying increase in the number of off-periods of the fan. To offset this, however, there was a decrease in the amount of variation of the living zone temperature to 2.4 F. Although the sun room cannot be regarded as the proper place for the location of a master thermostat, on account of the pronounced effects of sun exposure on that room, the tests did indicate that an increase in sensitivity of the room thermostat is desirable since the cooling period during the off-period of the fan was shortened. They also indicated that the room thermostat should preferably be placed in a room that is subject to rather wide fluctuations in temperature if sensitive operation of the instrument is desired.

All of the three series of tests just described were made with intermittent operation of the fan. In the fourth series of tests, the same room thermostat was located at the 60-in. level in the dining room, and the control instruments were so arranged that the fan operated as long as the bonnet air temperature was greater than 125 F. In all of these tests, however, the burner was operated intermittently. Due to the fact that the volume of air circulated was large, the fan did not run continuously even in zero weather. In order for the fan to operate continuously during zero weather, the air delivery would have had to be reduced considerably from the 1,675 cfm delivered during the tests. In any case, the low temperature limit control in the bonnet operated so that the average frequency of fan operation was 2.1 times per hour for zero weather. This was materially less than the 4.6 times per hour obtained for normal intermittent operation of the fan. Since the fan was operated as long as the temperature in the bonnet was 125 F, or more, there was some tendency for the air temperatures in the room to over-run, and there was also a slight delay in the delivery of sufficient heat on the first demand of the thermostat. As a result the maximum variation in the living zone temperature was 3.3 F instead of the 2.7 F variation obtained with normal intermittent operation.

Summary

From a study of the four methods of control used in these tests it was evident that more frequent cyclical operation of the fan, produced by more sensitive action of the room thermostat, tended to reduce the length of the off-periods of the fan, and hence the temperature variation in the living zone. The possible improvements in this direction are to some extent limited. It was also indicated from the tests made with the fan operation limited to bonnet temperatures above 125 F that long operation of the fan necessarily tended to reduce the number of off-periods occurring during the day, but did not necessarily reduce the length of each off-period. The latter method, however, entails greater operating costs for the fan as compared with intermittent operation with the fan controlled primarily by the room thermostat. The possible application of a two-speed fan control which would retain the desirable features of long operation without the accompanying added fan cost was indicated from these studies and such tests were made during the following season.

Performance Characteristics With a Two Speed Fan

Preliminary Statement

In the design of a duct system for a forced-air heating plant the assumption is tacitly made that the operation of the fan will be continuous. Although continuous operation of the fan is commonly used in practice for large heating installations, in a large majority of the smaller installations the greater electrical cost accompanying continuous operation has resulted in the extensive use of an intermittently operated fan controlled from a master room thermostat. In certain types of large installations and under extreme weather conditions the latter method of fan operation may not prove to be entirely satisfactory, as has been indicated in the preceding section. Hence a method of operation which combines long operating periods for the fan with reasonable electrical costs is worthy of investigation. Such an investigation of the performance of a two-speed fan in a forced-air heating system was made during the heating season

of 1936-1937. It should be noted that the purpose in using two-speeds for the fan was to vary the volume of air delivered, and that this could also be accomplished by using dampers to control the output of a single-speed fan. The results obtained were compared with those obtained with the usual single-speed, intermittently operated fan.

Method of Conducting Tests

In the tests made with a single-speed fan (Series 2-36), the speed of the fan was adjusted by means of a variable diameter pulley so that the air delivery was maintained at 1,675 cfm. In the tests made with the two-speed fan (Series 1-36), the same high speed was retained so that an air delivery of 1,675 cfm was obtained, and a low speed was selected such that an air delivery of 1,000 cfm was obtained. In this particular installation it was not possible to obtain a lower fan speed and hence a lower air delivery. It is of interest to note that this air delivery at low-speed, amounting to 1,000 cfm, or approximately 60 per cent of the delivery at high speed, was materially higher than the normal air deliveries obtained with the gravity warm-air furnace in the Research Residence. In the latter installation, air deliveries ranging from approximately 500 cfm to 800 cfm were reported.[6]

In the case of the tests with the single-speed fan operated intermittently, the control[7] of the heating plant was accomplished by means of a room thermostat operating to start and to stop the combustion process and the circulating fan as shown in Fig. 1. This room thermostat was used in conjunction with two bonnet thermostats, one of which served to stop the fan when the bonnet air temperature became less than 125 F, and the other of which served to stop the burner when the bonnet air temperature became greater than 175 F. The room thermostat, which was of the heat-anticipating type, was located on an inside wall of the dining room at a height of 30 in. from the floor and was adjusted to maintain an average air temperature of approximately 72 F at the 60-in. level in all of the rooms of the Residence.

In the case of the tests made with the two-speed fan the room thermostat was not changed, but modifications were made in the electrical connections for the bonnet thermostats and also in the settings of the bonnet thermostats. The control of the heating plant was accomplished by means of the room thermostat operating to start and stop the combustion process only as shown in Fig. 1. When the bonnet air temperature was less than 125 F the fan did not operate; when the bonnet air temperature was between 125 F and 160 F the fan was operated at low speed; and when the bonnet air temperature exceeded 160 F the fan was operated at high speed. In both series of tests the same control instruments were used in order to eliminate any effects due to differences in the sensitivity and setting of the instruments; and the same electric motor (½ hp capacitor type, 110 volts, 60 cycle, 1,140 rpm maximum speed) was used for the fan in order to eliminate effects due to differences in motor characteristics.

Either periodic or continuous records were made of all significant temperatures in the rooms and in the duct system as explained in the previous section. In addition to the temperature records, complete data were obtained for each 24-hour test period on the fuel consumption, the total integrated time of operation of the fan and of the burner, the total electrical energy consumption of the fan and of the burner, and the total number of both the off-periods and the on-periods of the circulating fan.

Limitation of Results

It should be recognized that the results obtained in these tests were influenced to a large extent by the conditions which were imposed and by the performance of the equipment used. For example, the selection of 1,000 cfm delivery for low speed operation of the two-speed fan was quite arbitrary, and the results obtained would have been modified slightly if a delivery either greater or less than this had been used. Also the relative power costs for a two-speed fan motor and a single-speed fan motor would be dependent on the special characteristics of the motor used. These restrictions and limitations which apply to practically all tests made under similar service conditions do not, however, invalidate the results obtained, provided that the operating conditions do not deviate too far from those which would be considered as normal in ordinary applications.

Fuel Consumption

The operating conditions which were maintained for the oil burner and the oil-burning furnace were identical in the two series of tests. The oil input rate was approximately 13 lb per hour, the air supply to the burner was adjusted to maintain 9.5 per cent of CO_2 in the flue gas, and the draft in the combustion chamber was maintained at 0.02 in. of water gage. For both series of tests the data on fuel consumption were obtained for a

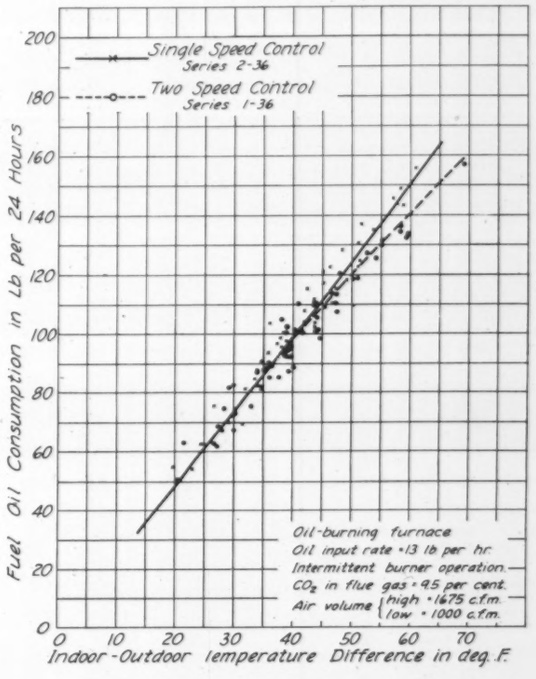

Fig. 4—Fuel oil consumption for two methods of control

[6]University of Illinois, *Engineering Experiment Station Bulletin* No. 189, by A. C. Willard, A. P. Kratz, and V. S. Day, Investigation of Warm-Air Furnaces and Heating Systems, Part IV., January 8, 1929, p. 56.
[7]Loc. Cit. See Note 3.

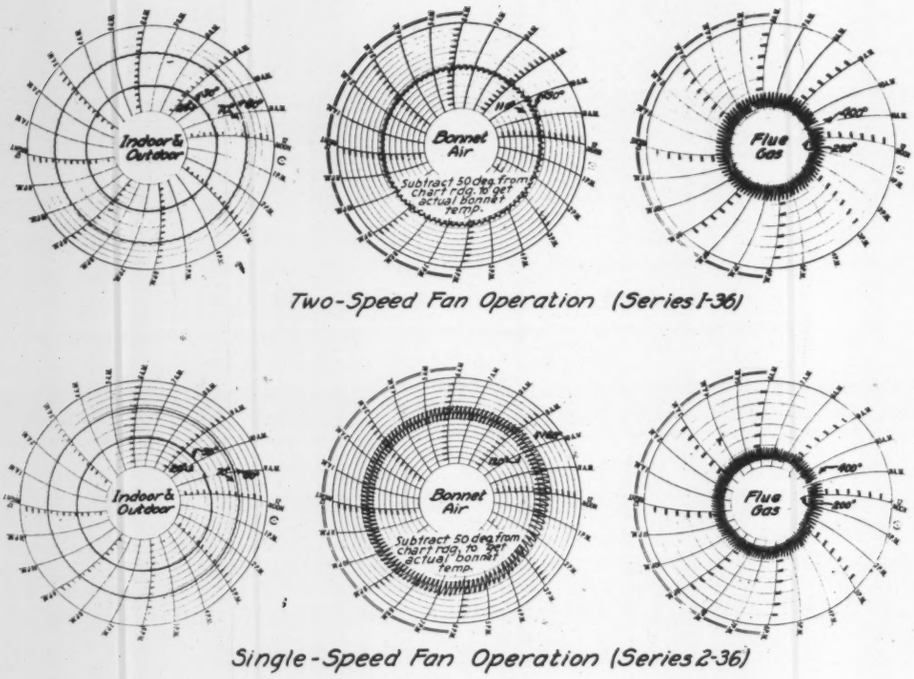
Indoor & Outdoor
Bonnet Air
Subtract 50 deg from chart rdg. to get actual bonnet temp.
Flue Gas
Two-Speed Fan Operation (Series 1-36)
Indoor & Outdoor
Bonnet Air
Subtract 50 deg from chart rdg. to get actual bonnet temp.
Flue Gas
Single-Speed Fan Operation (Series 2-36)

Fig. 5—Temperature records for two methods of control

wide range of weather conditions, and the consumption of fuel oil in pounds per 24 hours has been plotted against the difference in temperature existing between the indoors and the outdoors for the same period, as shown in Fig. 4. The plotted points deviate to some extent from the curve representing the average of the observed data, and these deviations can be attributed to the wind and sun effects which cannot be represented on a curve based on temperature difference alone.

It may be noted from Fig. 4 that the full line represents the data obtained with the single-speed fan, while the broken line represents that obtained with the two-speed fan. For milder weather conditions, or for indoor-outdoor differences less than 45 F, very little difference in the fuel consumption resulted with the two methods of operation. For colder weather, or for indoor-outdoor differences greater than 45 F, the fuel consumption with the two-speed operation was slightly less than that with single-speed intermittent operation. This reduction in fuel consumption varied from 3 per cent to 8 per cent for indoor-outdoor differences varying from 50 F to 65 F. The reduction in fuel consumption obtained with lower fan speeds cannot be attributed to higher bonnet efficiencies maintained during the periods of burner operation, since previous tests[8] had indicated that the higher bonnet efficiencies accompanied the larger quantities of air circulated over the heating surfaces. However, as may be noted from Fig. 5, the flue losses during the off-period of the burner were apparently lower with the two-speed fan than they were with the single-speed fan. In the latter case the fan was stopped at the same time that the burner was stopped, and the reserve heat in the furnace tended to raise the temperature of the air in the bonnet. However, in the case of the two-speed fan, the fan continued to operate for some time after the burner had stopped and the residual heat in the furnace was completely transferred from the bonnet to the rooms. It is probable, therefore, that with two-speed fan operation the reduction in the loss occurring in the hot gases passing up the chimney during the off-period of the burner was equal to or slightly greater than the slight increase in these losses during the actual combustion process. Since the speed of the fan was low and the amount of residual heat was limited, the temperature overrun that accompanied these comparatively long periods of fan operation after the room was satisfied was not of sufficient consequence to be objectionable. The difference in seasonal fuel consumption for the two cases would be small, and for all practical purposes it may be concluded that the fuel consumption for the two methods of operation was essentially the same.

[8]Loc. Cit. See Note 2.

Burner Operation

The data obtained for the operation of the burner are shown in Fig. 6. It may be noted from the top pair of curves that with low speed operation the number of cycles of operation was materially less than that with

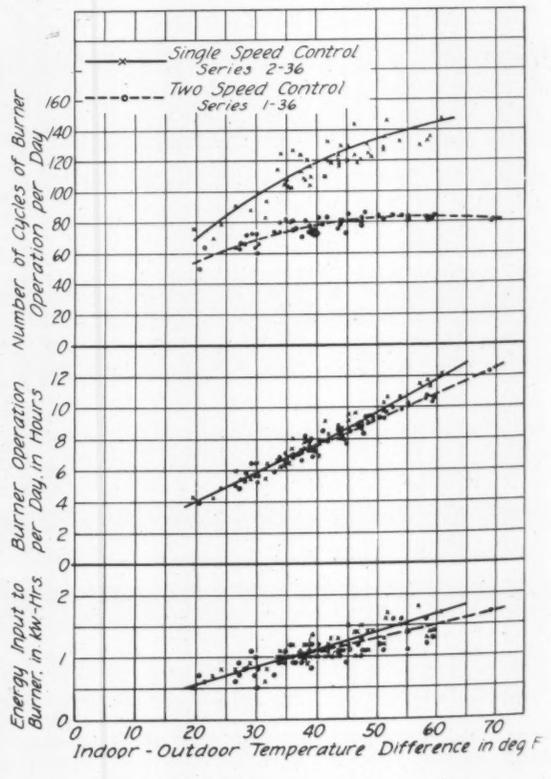
Single Speed Control Series 2-36
Two Speed Control Series 1-36
Number of Cycles of Burner Operation per Day
Burner Operation per Day, in Hours
Energy Input to Burner, in kW-Hrs
Indoor - Outdoor Temperature Difference in deg F

Fig. 6—Performance of burner with two methods of control

Table 2—Data on Operation of Two-Speed Fan

Indoor-Outdoor Temp. Difference in Deg F	Total Fan Operation in Hours		Increase in Running Time of Two-Speed Fan Operation Over Single-Speed Operation, Per Cent
	Single-Speed	Two-Speed	
20	3.9	7.3	87
40	7.8	14.2	82
60	12.0	20.6	72

high speed operation. Since the total time of burner operation per day was approximately the same in the two cases, as shown in the middle pair of curves, the average length of the on-period of the burner was greater with the lower fan speed. The latter may also be deduced from the flue gas temperatures shown in Fig. 5. The energy input to the burner motor was approximately the same for the two cases.

Fan Operation

Similar data for the circulating fan are shown in Fig. 7. It may be observed that marked differences were obtained in the total time of fan operation for a 24-hour period, as is also indicated by Table 2. The total running time accompanying two-speed operation was approximately 80 per cent greater than that for single-speed operation of the fan. In fact for an indoor-outdoor temperature difference of 60 F the fan operated 20.6 hours out of 24, or 86 per cent of the time, when the two-speed arrangement was used.

The average power consumption of the electric motor for the fan was 0.38 kw with high speed operation and 0.25 kw with low speed operation. In other words although 0.23 kw was required per 1,000 cfm delivery at high speed, as a result of slightly lower motor efficiencies at the lower speed, the rate at the low speed was 0.25 kw per 1,000 cfm delivery.

The total energy consumption with the two-speed fan operation was from 9 to 21 per cent greater than that for single-speed operation, depending upon the severity of the weather, with an average value of approximately 15 per cent. As indicated previously these comparative values are dependent to a large extent on the performance characteristics of the motor used.

In general when the costs for fuel, for burner power, and for fan power are all taken into consideration, the total daily operating costs for the two methods of operation may be considered as practically the same.

Temperature Differential in Rooms

The results of an analysis of the average room temperature conditions maintained in all of the rooms of the Residence are shown in Fig. 8, in which the data for the differences in temperature existing between the breathing level and the floor and between the ceiling and the breathing level have been plotted against the indoor-outdoor temperature difference. It may be observed that on the average, the temperature of the air near the floor with two-speed fan operation was approximately 0.4 F higher than that obtained with single-speed operation, although no appreciable difference was observed in the ceiling temperatures. Furthermore, the average value of the register air temperature was approximately 104 F with the two-speed fan owing to the preponderance of low-speed operation, and approximately 117 F

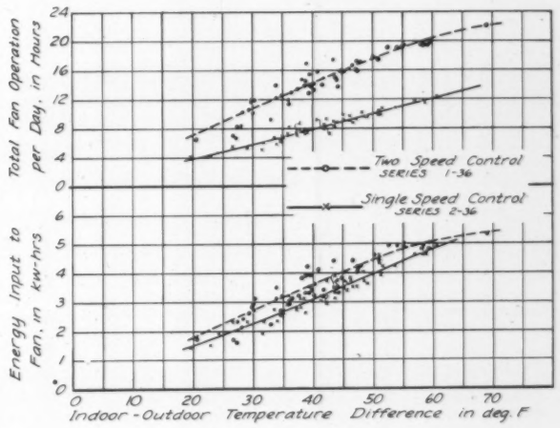
Total Fan Operation per Day, in Hours
Two Speed Control SERIES 1-36
Single Speed Control SERIES 2-36
Energy Input to Fan, in kw-hrs
Indoor - Outdoor Temperature Difference in deg. F

Fig. 7—Performance of fan for two methods of control

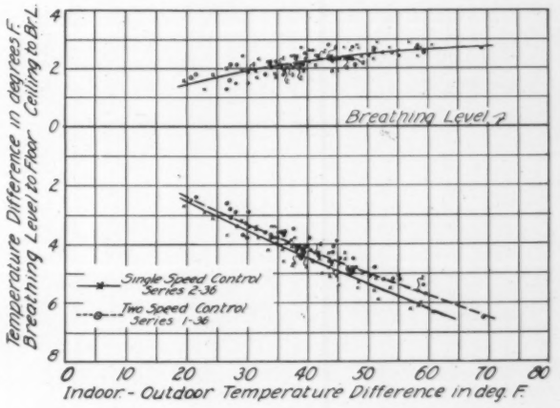
Temperature Difference in degrees F. Breathing Level to Floor Ceiling to Br. L.
Breathing Level
Single Speed Control Series 2-36
Two Speed Control Series 1-36
Indoor - Outdoor Temperature Difference in deg. F

Fig. 8—Room temperature differential for two methods of control

with single-speed operation. It is, therefore, probable that the lower temperature of the air introduced into the room during the longer periods of low speed operation may serve as an explanation for the slightly better average room temperatures that were maintained when the two-speed fan was used.

Off-Period of Fan

In the preceding discussion the differences in the results obtained with the two methods of fan operation have been shown to be comparatively small. However, a study of the temperature fluctuations in any given room during a complete cycle of fan operation, as well as a study of the distribution of temperatures in the different rooms, has indicated that the comfort conditions in the room were markedly improved with the two-speed operation of the fan. In general, the conditions of discomfort occurred only during the off-periods of the fan, when no heat was being delivered to the room, and the effective temperature in the living zone had decreased to a value less than that which was considered as satisfactory. Obviously, improvements in the room comfort conditions could be effected by a reduction in the number of off-periods, in a reduction in the average duration of the off-period, or in a reduction in both factors.

The upper set of curves in Fig. 9 shows the number of primary off-periods of the fan per day. As is indicated in the inset shown at the top of the figure, the

primary off-period in the case of two-speed fan operation was regarded as the longer of the two off-periods that usually follow a primary fan cycle. It is this primary off-period, rather than the very short secondary off-period, that is of significance in this study. It may be noted from the upper set of curves that the number of primary off-periods per day was much smaller for two-

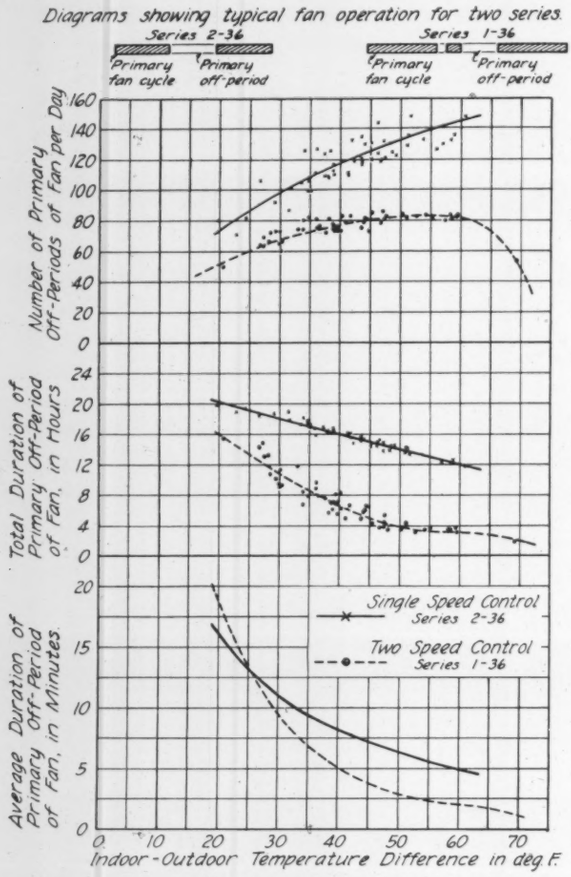
Diagrams showing typical fan operation for two series
Series 2-36
Primary fan cycle
Primary off-period
Series 1-36
Primary fan cycle
Primary off-period
Number of Primary Off-Periods of Fan per Day
Total Duration of Primary Off-Period of Fan, in Hours
Average Duration of Primary Off-Period of Fan, in Minutes
Single Speed Control Series 2-36
Two Speed Control Series 1-36
Indoor-Outdoor Temperature Difference in deg. F.

Fig. 9—Off-period duration of fan with oil-burning furnace

speed fan operation than it was for single-speed fan operation. For example, for an indoor-outdoor temperature difference of 60 F the numbers of off-periods were 82 and 145 respectively, for two-speed and single-speed operation.

The middle pair of curves shows that, in the case of two-speed operation, the total duration of time represented by the summation of the primary off-periods per day was also less than that for single-speed operation. For an indoor-outdoor temperature difference of 60 F the durations were 3.0 hours and 12 hours, respectively.

The lower pair of curves in Fig. 9 shows the average duration of the primary off-period of the fan. It may be noted that for both series of tests the average duration of the off-period diminished as the weather conditions became more severe. For an indoor-outdoor difference of 60 F the average durations of the primary off-periods were 3 min and 5 min respectively for two-speed and single-speed operation. Hence, from the standpoint of fewer number of off-periods per day and also from that of shorter duration for each off-period, it may be concluded that the heat supply to the rooms was more nearly continuous and that conditions were more favorable in the case of two-speed fan operation than in the case of single-speed operation.

Temperature Variation in Rooms

It was also observed that more nearly continuous and uninterrupted heat supply resulted in better room temperature conditions. Studies of the variations in the temperature of the air during one complete cycle of operation of the circulating fan were made in the living room. This room was 13 ft 6 in. by 20 ft and had the north, east, and south walls exposed. The supply register was located in the baseboard of the inside west wall, midway between the north and south walls. The register used in this study was 10 in. by 12 in. of the perforated grille type, and introduced the air into the room at an angle of approximately 45 deg from the horizontal. The return air grille, which was 30 in. by 8 in., was located in the floor in the north-east corner of the room.

Five preliminary tests were made including both high and low speed operation of the fan, and with the outdoor temperatures ranging between 4.5 F and 17.0 F. Each test comprised one complete cycle of fan operation and was made in order to determine the amount of deviation occurring between the temperature in the center of the room and those observed in the four corners of the room. These preliminary tests indicated that the average deviations of the corner readings from the center reading were very small; amounting to +0.02 F at the breathing level and —0.25 F at the floor. Furthermore, these deviations were not affected to any extent by the changes in the fan speed. There was some indication that the northwest corner was slightly warmer than, and that the southeast corner was slightly colder than the other parts of the room. In general it may be concluded that the air temperatures observed in the center of a given horizontal plane in the room are representative of those prevailing at all points in the same plane in the room.

In a second set of tests the temperature variations occurring during one complete cycle of operation of the fan were investigated in the living room by means of thermocouples placed on a standard which was located in the central axis of the room. The temperature observations were made at intervals of 1 min during the complete cycle of operation. The differences between the maximum and the minimum temperatures observed at each of the three levels in the room are shown in Table 3. It may be observed that the variations in floor temperature were the same with both methods of operation, but the variations in temperature at the breathing level and ceiling were much smaller with two-speed operation than they were with single-speed operation.

In a third set of tests, which were made in the east bedroom on the second story and in the sun room on

Table 3—Variations in Temperatures in Living Room[a]

Fan Operation	No. of Tests Averaged	Average Outdoor Temp., F	Maximum Temperature Variation During One Complete Fan Cycle, F		
			At Floor	At Br. Level	At Ceiling
Two-Speed	4	10.9	1.0	2.2	5.6
Single-Speed	2	11.5	1.0	3.2	8.0

[a]All observations made by means of thermocouples. Observations recorded each minute during one complete fan cycle. Tests made with no occupancy, no lights, and under fairly constant weather conditions with mild wind and very little sunshine.

the first story, the temperature distribution between the two stories of the house was investigated. It was observed that with two-speed operation, due to the fact that the gravity circulation to the second story rooms was diminished, and the total time that the fan operated was increased, the proportion of the total heat delivered to the first story rooms was slightly greater than that delivered with the single-speed operation. This in itself can be readily adjusted, but it does serve to emphasize the fact that the amount of dampering required on any given duct installation is dependent on the method of fan operation used, and is not the same for both continuous and intermittent operation of the fan.

It was indicated in a previous study that, in the case of all of the second story rooms, the temperature variations were small. Observations of temperatures in the east bedroom indicated that the actual temperature gradients from breathing level to floor were the same for the two methods of fan operation, and furthermore that the maximum variation in temperature in the living zone did not exceed 0.9 F for both series. It may be concluded, therefore, that the use of the two-speed fan did not change the very favorable conditions that existed in the second story rooms when the single-speed fan was in use.

In the case of the sun room, on the first story, and for tests made with an outdoor temperature of 6 F, it was observed that the use of the two-speed fan was accompanied by an increase in the magnitude of the living zone temperature of 0.6 F and by a decrease in the maximum temperature deviation in the living zone of 0.4 F, as compared with similar values obtained with single-speed fan operation. Both tendencies indicate that more favorable conditions were maintained with the use of the two-speed fan.

Summary

The use of a two-speed fan, that operates at low speed during the greater portion of the heating season and at high speed during heavy heating demands only, requires a more expensive motor and a more complicated control system than is required for the simpler single-speed fan operated intermittently. The total operating costs, including those for oil fuel, and for power consumed by the burner motor and fan motor, were approximately the same with both methods of fan operation. In the case of the two-speed fan, however, the fan was operated a greater proportion of the day, the total number of the primary off-periods of the fan was decreased, and the average duration of the off-periods of the fan was diminished. Furthermore, the temperature conditions in the room were improved. The temperature and comfort conditions in the second story rooms, which were entirely satisfactory with single-speed fan operation, were not changed when a two-speed fan was used. In the first story rooms, not only did the two-speed operation tend to increase the magnitude of the temperatures in the living zone, but it decreased the temperature fluctuation during each fan cycle. These improvements in the comfort conditions, consisting not only of a substantial reduction in the number and lengths of off-periods of the fan per day, but also of a noticeable improvement in the variations in air temperature in first story rooms, are such that the use of a two-speed fan should be given consideration in the application of forced-air heating to small and medium sized installations. The accompanying factors of quiet operation and more moderate air movement in the rooms may also be considered as advantageous features.

Table 4—Effective Temperature in Living Zone with Various Temperature Differentials

(Based on breathing level temperature of 72 F)

Air Temperatures, F			Effective Temperature in Living Zone,[a] Degrees
Breathing Level	Floor Level	Average Living Zone	
72	72	72.0	66.1
72	71	71.5	65.7
72	70	71.0	65.4
72	69	70.5	65.0
72	68	70.0	64.7
72	67	69.5	64.3
72	66	69.0	64.0
72	65	68.5	63.6
72	64	68.0	63.2
72	63	67.5	62.8

[a]Effective temperature based on a relative humidity of 30 per cent. Values would be increased approximately 0.6 deg for a relative humidity of 40 per cent.

Factors Affecting Temperature Differential Between Breathing Level and Floor

Preliminary Statement

In the first section of this report it was indicated that the condition of discomfort experienced in some of the first story rooms was partly attributable to the difference in the temperatures that existed between the breathing level and the floor, and partly to the fluctuations in the air temperature during a cyclical operation of the fan. It was also indicated in the preceding section that the variations in the air temperatures in the rooms could be reduced to some extent by the use of a two-speed fan. In addition, improvements of equal or even greater importance in the room comfort conditions may be effected by substantial reductions in the temperature differential between breathing level and floor, as illustrated in Table 4.

For ideal conditions of operation, such as is indicated in Table 4 with no difference in temperature existing between the breathing level and the floor, the effective temperature would be 66.1 deg. Under these conditions, the living zone dry-bulb temperature might decrease at least 4 F during a cyclical operation of the fan before the effective temperature approached 63 deg. On the other hand, if the temperature differential between breathing level and floor were 6 F, the effective temperature in the living zone would be 64 deg, and a reduction in the dry-bulb temperature of only 1 F in this zone would result in an effective temperature approaching the lower allowable limit of 63 deg. Furthermore, if the temperature differential between breathing level and floor became 8 F, the effective temperature would be 63.2 deg and any reduction in the temperature in the living zone would result in an effective temperature lower than the allowable limit. In the case of a room in which a large temperature differential exists, improvement in comfort conditions may be made either by increasing the temperature at the level of the thermostat, particularly as the weather gets colder, thus increasing the temperature at all levels; or by maintaining the same temperature at the control level and reducing the temperature differential. Since the former method is more wasteful of heat, it is apparent

that the only satisfactory solution of the problem consists in the maintenance of minimum temperature differentials in the given rooms. In connection with this study an extensive series of tests has been conducted over a period of years, the results of which will be briefly reviewed.

Table 5—Changes in Warm Air Registers in Research Residence[a]

Story	Room	Former Grille		New Deflecting Type Register				
		Width, In.	Height, In.	Width, In.	Height, In.	Type of Projection: Vertical Plane	Type of Projection: Horizontal Plane	Free Area[b] Per Cent
First	Living	12	10	12	6	Straight out	Three way deflection in all registers on the first story	Approx. 90
	Hall	14	12	14	4	Straight out		
	Dining	12	10	12	6	Straight out		
	Sun, So.	12	10	12	10	Straight out		
	Sun, No.	12	10	12	10	Straight out		
	Kitchen	14	12	14	10	Straight out		
Second	E. Bed.	12	10	12	6	Straight out	Three way deflection	Approx.
	SW. Bed.	12	9	12	6	Straight out	Deflection to right	80
	Bath	10	8	10	8	Straight out	Deflection to right	
	NW. Bed.	12	10	12	10	Straight out	Three way deflection	
Third	E. Dorm.	10	8	12	10	Deflection 22 deg down	None	Approx.
	W. Dorm.	10	8	12	10	Deflection 22 deg down	None	86

[a]All new registers selected on the basis of an average register velocity of approximately 500 fpm. All registers located in the baseboard. Change in registers made in April, 1937.
[b]Free area percentages based on opening size and not on gross size or trade designation size.

Effect of Storm Sash

In a previous publication[9] it was shown that by equipping the windows with tightly fitting storm-sash, the room temperatures at the floor level were increased, although no observable difference in the temperatures at the ceiling was recorded. The use of the additional barrier of glass against heat flow resulted in an increase in the temperature of the inner surface of the glass and in an increase in the temperature of the air which flowed down over the window sills and settled in the lower portion of the room. The data obtained in the dining room indicated that the increase in the temperature at the floor level was approximately 0.6 F for an outdoor temperature of 50 F and was approximately 1.8 F for an outdoor temperature of 0 F.

In a similar manner, the use of sidewall insulation should tend to increase the temperature of the air flowing down the wall and hence tend to increase the temperature at the floor level. Adequate protection of the windows and walls will, therefore, not only reduce the loss of heat from the structure, but will also promote more comfortable room conditions by increasing temperatures in the living zone, and by minimizing the heat loss from the body to cold surfaces.

Effect of Air Temperatures

Incidental to the tests made with the oil-burning furnace and with the conversion unit, it was observed that although there was no difference in the temperatures at the floor obtained with the two installations, the temperatures at the ceiling in the case of the oil-burning furnace were slightly higher than they were with the conversion unit. The same quantity of air (1,675 cfm) was circulated in both cases, but the temperature of the air leaving the furnace (as measured in the north trunk duct) was approximately 4 deg higher for the oil-burning furnace than it was for the conversion unit under comparable weather conditions. This slightly warmer air entered the rooms through registers of the perforated grille type and rising to the ceiling caused slightly warmer temperatures at this level. The excess was of the order of 0.2 F and 0.8 F, respectively, for indoor-outdoor temperature differences of 30 F and 70 F.

Effect of Air Volumes

The average temperature differentials for all of the rooms in the Residence have been recorded for each of the three main types of heating systems that have been installed. The temperature differentials, obtained for the gravity warm-air, auxiliary-fan, and the forced-air system, are shown in Fig. 10. In all cases, the same type of register, consisting of a perforated grille, was used, and hence the warm air was introduced into the rooms in the same manner. In the case of the forced-air system, the differential for the sun room has been included in the average, whereas it was not included in

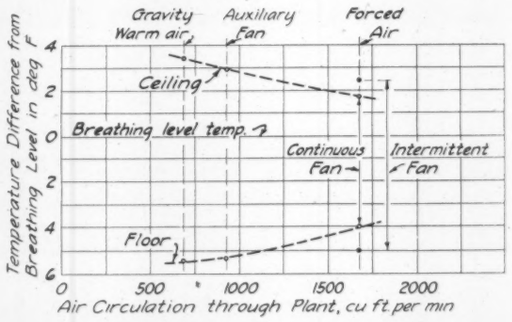

Fig. 10—Temperature differentials with gravity, auxiliary fan, and forced-air systems

the case of the other two systems, in which the sun room was not heated. Hence, the results as shown tend slightly to favor the gravity and auxiliary-fan installations, since the inclusion of a large value for the sun room in the average would give larger differentials than those actually recorded. Even so, however, it may be noted that the smallest temperature differential was obtained with the forced-air system, particularly with continuous operation of the fan. This reduction in temperature differential may be attributed not only to the increase in the quantity of air which was circulated, but also to the decrease in the temperature of the air which was introduced into the rooms.

Effect of Register Types in East Bedroom

There has been reported[10] an extensive series of tests made to determine the effect of various types of warm-air registers on the temperature gradient in the room.

[9]Fuel Saving Resulting from the Use of Storm Windows and Doors, by A. P. Kratz and S. Konzo. (A.S.H.V.E. Transactions, Vol. 42, 1936, pp. 87-98.)

[10]University of Illinois, *Engineering Experiment Station Bulletin* No. 266, by A. P. Kratz and S. Konzo.

These tests which were made in the east bedroom under similar conditions of operation, indicated that for equal register air velocities, the minimum temperature differential was obtained when baseboard registers were used containing deflectors which projected the air slightly downward and thus spread the warm air near the floor.

Effect of Deflecting Types of Register in all of the Rooms

These studies were extended, during the latter part of the 1936-1937 heating season, to include all of the 12 baseboard registers in the Residence. The large perforated grille types of register, which had been in place since the construction of the house in 1924 were replaced with smaller, deflecting type registers, the sizes of which are given in Table 5. The new registers were of such construction that the air was projected either horizontally or downward into the room near the floor level and in some cases also deflected sidewise. In the bathroom and southwest bedroom on the second story, the louvers in the registers were adjusted so that the air was deflected away from walls a distance of 3 ft in front of the registers. In the case of the bathroom and the two dormitory rooms, in which the register was located 3 in. above the baseboard, the air was projected downwards towards the floor.

As in all studies on temperature differentials the average temperatures in all of the rooms at the ceiling level, breathing level, and floor level were obtained for each day, over a wide range of weather conditions. The results from the tests, which were made under conditions of operation identical with those for single-speed intermittent operation of the fan in the oil-burning furnace unit, have been plotted in Fig. 11. For purposes of comparison the temperature differential curves shown in Fig. 8 have been transferred, and are shown as broken line curves in Fig. 11. It may be noted that a very appreciable improvement in the room temperature conditions was obtained with the new registers. For an indoor-outdoor temperature difference of 50 F for example, the total temperature differential from floor to ceiling has been reduced from 7.8 F to 4.1 F.

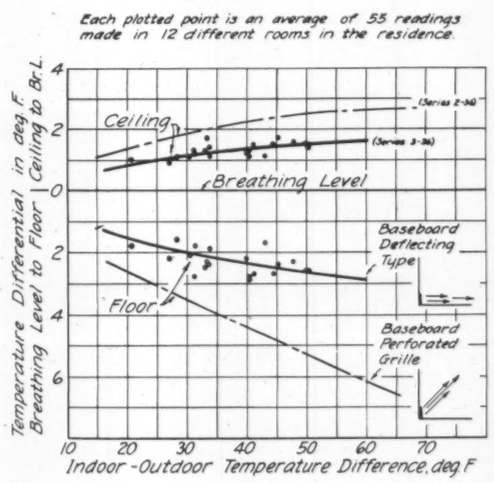
Each plotted point is an average of 55 readings made in 12 different rooms in the residence.
Temperature Differential in deg F.
Breathing Level to Floor | Ceiling to Br.L.
Ceiling
Breathing Level
Floor
Baseboard Deflecting Type
Baseboard Perforated Grille
Indoor-Outdoor Temperature Difference, deg F

Fig. 11—Room temperature differentials with two types of registers, (oil-burning furnace, intermittent single-speed fan)

Furthermore, the greatest improvement was observed in the differential existing from the floor to the breathing level. For an indoor-outdoor difference of 60 F, the temperature differential from floor to breathing level was reduced from approximately 6 F to 3 F. As may be observed from Table 4 this improvement in the living zone temperature was equivalent to an increase in the effective temperature of 1 deg. This improvement in the temperature differential, particularly in the living zone, represents the largest improvement effected by any single factor which has been studied, and substantiates the conclusions which were obtained from the earlier tests made in the east bedroom alone.

Air Flow Conditions in Rooms

The distribution and magnitude of the air flow into each of the 12 rooms, before and after the registers were changed, were studied by means of anemometers and smoke in order to determine the shape and location of the envelope of the air stream. In every case in which the perforated grille type of register was used, the air was projected into the room at an angle of from approximately 45 to 60 deg and the warm air rose directly to the ceiling. In addition the air stream was confined to a small portion of the room, as shown by the envelopes in Fig. 12, and in this way local effects were accentuated. After the registers were changed the envelopes, as shown in Fig. 13, were spread out in a horizontal direction and confined to within about 10 in. above the floor, thus both diminishing any local effects and confining them to a region in which they would not be objectionable.

Summary

There remains little doubt that, by the proper application of deflecting types of register, some of the problems arising from the variation in room temperatures may be avoided. Their application should be given especial consideration in houses that are not well protected against heat loss, in rooms that have excessive exposure, in isolated rooms, and in rooms that are located on the first story.

General Summary and Conclusions

The following summary and conclusions may be considered as applying to the Research Residence and the conditions under which the tests were conducted.

(1) It was observed that although the air temperature at the breathing level was maintained at approximately 72 F for all weather conditions, a certain amount of discomfort was experienced in some of the first story rooms, particularly when the outdoor air temperature was lower than approximately 15 F. This condition was especially noticeable during the off-periods of the fan in the forced-air heating system.

(2) The cyclical variation in temperature, during the on-periods and off-periods of the fan, in the living zone of the second and third story rooms was quite small, whereas that in first story rooms was about three times as large.

(3) More frequent cyclical operation of the fan tended to reduce the length of the off-periods of the fan and hence the temperature variation in the living zone. Furthermore, the number of off-periods occurring during the day was decreased when a method of control was used which provided for practically continuous fan operation.

(4) A comparison of the results of the tests made with a single-speed fan and those made with a two-speed fan indicated that the total daily costs for the two methods of operation may be considered as practically the same. However, from the standpoint of fewer number of off-periods per day and also from

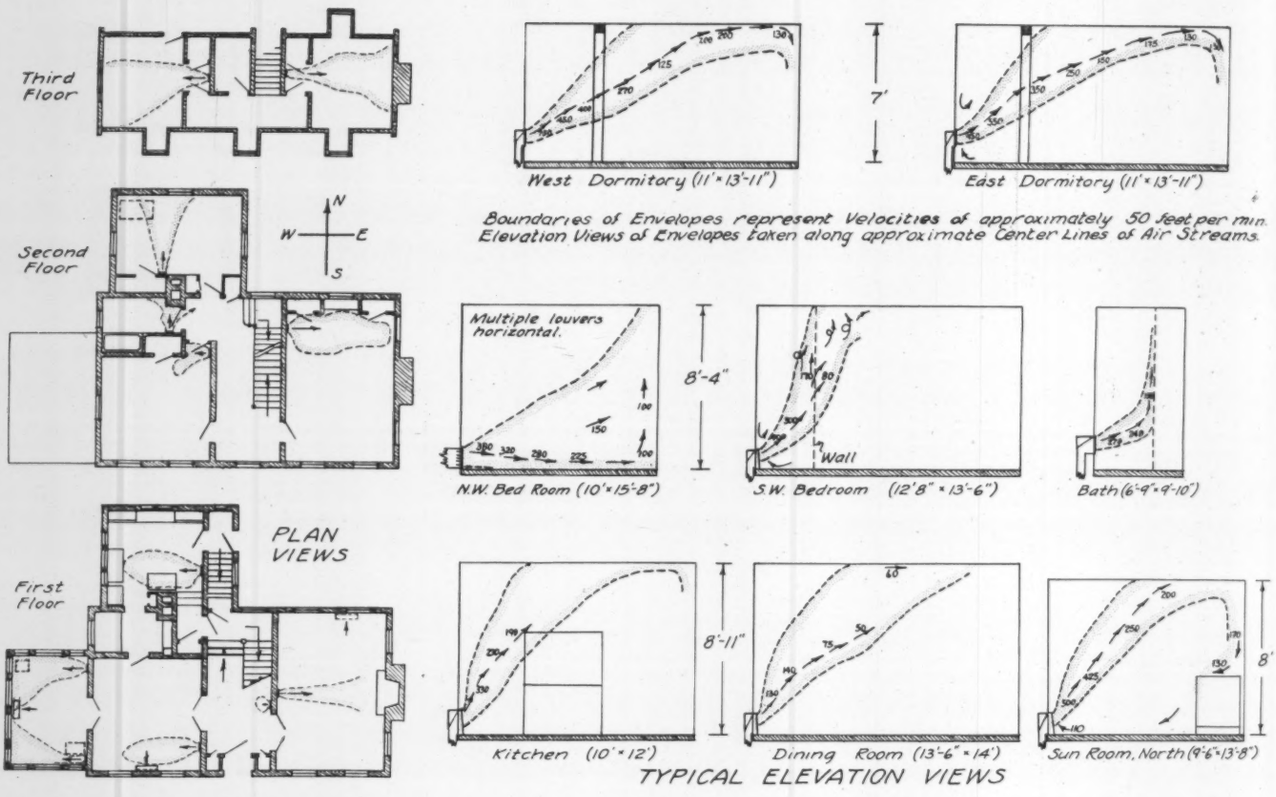

Fig. 12—Plan and typical elevation views showing air velocity distribution in rooms, baseboard perforated grille registers

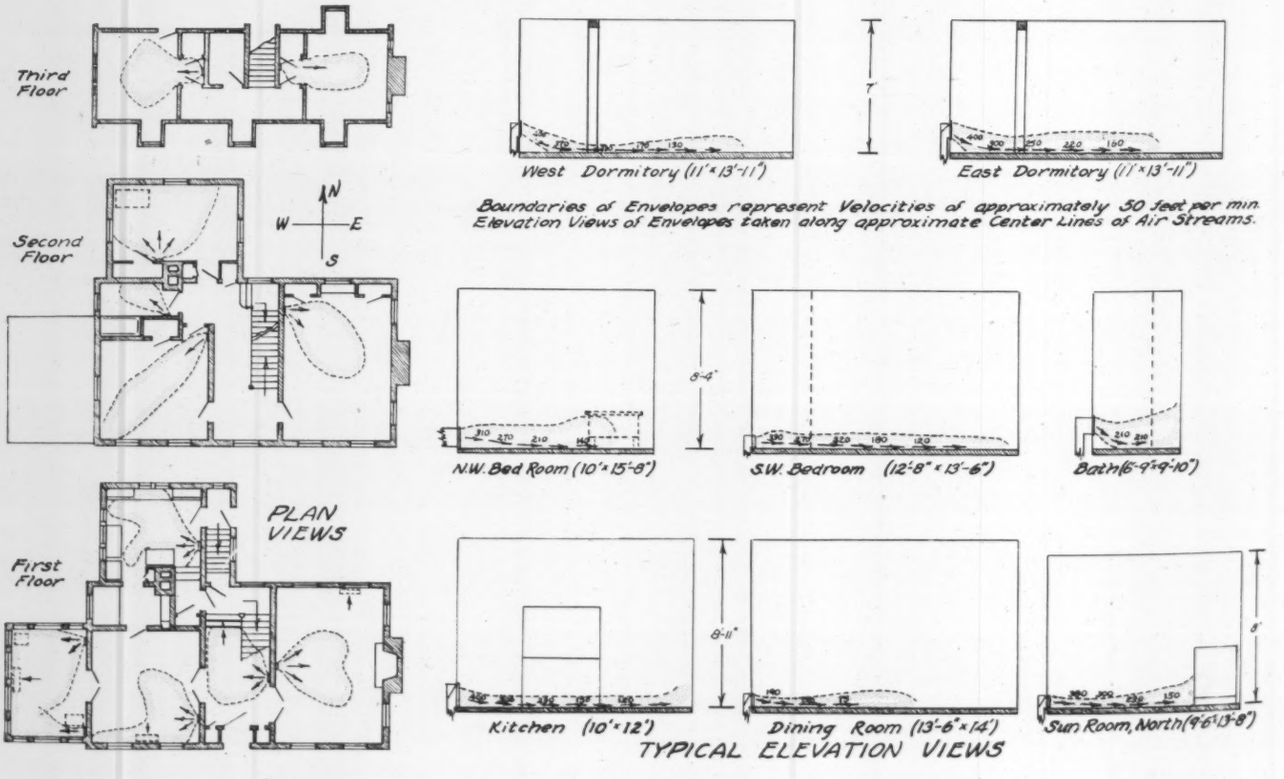

Fig. 13—Plan and typical elevation views showing air velocity distribution in rooms, baseboard deflection registers

that of shorter duration for each off-period, it may be concluded that the heat supply to the rooms was more nearly continuous and that conditions were more favorable when the two-speed rather than the single-speed fan was used.

(5) The amount of dampering required on any given duct installation is dependent on the method of fan operation used, and is not the same for both continuous and intermittent operation of the fan.

(6) A reduction in the temperature differential between the breathing level and the floor may be effected by the use of storm sash, by the use of large volumes of circulating air at lower temperatures, and by the use of registers which deflect the air towards the floor. The results obtained from the use of deflecting types of register located in the baseboard were better than those obtained with the perforated grill type of register in the same location.

Acknowledgments

The results presented in this paper were obtained in connection with the investigation of warm-air furnaces and heating systems in the Research Residence,[11] at the University of Illinois, conducted by the Engineering Experiment Station of which M. L. Enger, Dean of the College of Engineering, is the director, and in the Department of Mechanical Engineering of which O. A. Leutwiler, Professor of Mechanical Engineering Design, is the head. This investigation is a cooperative project sponsored jointly by the *National Warm Air Heating and Air Conditioning Association* and the Engineering Experiment Station. These results will ultimately comprise part of a bulletin of the Engineering Experiment Station. Acknowledgments are also due to: R. B. Engdahl, research graduate assistant, and to J. S. Cunningham, former research assistant, for services rendered in connection with the investigation, and to the various manufacturers who cooperated by furnishing instruments and equipment.

[11]The Research Residence in Urbana, Illinois was built, furnished, and completely equipped specifically for research work in warm-air heating by the *National Warm-Air Heating and Air Conditioning Association* in December, 1924.

The Inspiration of Society Membership

The following article on Why I Have Continued My Interest in the Society has been prepared by Prof. F. B. Rowley, who was president of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS in 1932 and is director of the Engineering Experiment Station of the University of Minnesota at Minneapolis, Minn. Professor Rowley has responded to the request of R. C. Bolsinger, chairman of the Society's Membership Committee, who has arranged to present messages from A.S.H.V.E. members of long standing in the Journal Section each month.

WHY I HAVE CONTINUED MY INTEREST IN THE SOCIETY

When my old friend, Ray Bolsinger, Chairman of the Membership Committee, asked me to account for my continued interest in the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS long after I had passed my apparent usefulness, it set me to thinking as to just why I had joined the Society and why it had become such a vital part of my activities for the past 20 years. An answer to this question requires some personal history which I trust will be excused.

I became interested in the field of heating and ventilating about 25 years ago and from 1917 to 1919 it was my good fortune to be closely associated with John R. Allen, that inspiring and enthusiastic student in the field who came to Minnesota as Dean of the College of Engineering and Architecture. In 1918 a local chapter was formed at Minnesota and I joined the Society as a charter member of that group. At that time I began to attend some of the Annual and Semi-Annual Meetings of the Society and, even though I felt a little timid at taking an active part, I sat in the meetings and as I heard the various papers presented and discussed I realized that here was a group of leaders in the profession who were dealing with some of the fundamental problems and trying to straighten out conflicting theories and practices. These men seemed to be looking forward to the time when the art of heating and ventilating would be put upon a more scientific basis and the so-called **rule of thumb** methods would make way for more exact procedure. It was evident that this group had much to offer me in any progress which I might hope to make in the field. It was an inspiration to be with the group, and even though I felt like an intruder at the first meetings I soon found that the older and more experienced men were very willing to increase the circle and include the newer and younger members.

The Society continued to grow in its activities and become more and more of an absorbing interest to me. It was extremely helpful professionally and technically, and incidentally a place where I made some of my most highly prized friendships. The benefits of the Society to its members need no extended arguments. Its activities are professional, technical and social. The Society has been outstanding in that it has not been content to accept and organize for practical purposes existing theories and data only, but that it has also maintained its own research laboratory and a close cooperation with other research institutions in order to collect and organize new information. The success of the Society is evidenced by the fact that its publications are standard references in the profession and the GUIDE is used as a text in many universities and educational institutions.

It has always been an inspiration to me to be associated with the Society and it has contributed to me far more than I could return to it. These contributions have been varied in character and have increased as time has passed. I feel strongly that no young man who wants to develop and be a part of the profession can afford to stay outside of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS. He will get large returns on his investment, and the more he contributes the greater will be his returns. He should not, however, accept membership from a purely selfish point of view. The Society does not seek members for mere numbers but primarily to get those men together who are enthusiastic and capable of advancing the profession to higher standards. This, in brief, is what I have found in the Society and why I have continued my interest in it.

Summer Cooling Requirements of 275 Workers in an Air Conditioned Office

By A. B. Newton* (*NON-MEMBER*), F. C. Houghten** (*MEMBER*), Carl Gutberlet*** and R. W. Qualley† (*NON-MEMBERS*)

This paper reports the results of research, sponsored by the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS' Committee on Research, conducted under the supervision of the Technical Advisory Committee on Comfort Air Conditioning

COOLING requirements for summer air conditioning have been the subject of extended research by the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS in Pittsburgh, and by the Laboratory in cooperation with the Ontario Research Foundation of Toronto, and the Texas Agricultural and Mechanical College. Two papers,[1, 2] giving the results of these studies have been published, indicating the requirements of certain definite effective temperatures with considerable variation in relative humidity. Optimum effective temperatures of 73 deg were indicated for Pittsburgh and Texas, and an effective temperature of about two degrees lower for Toronto.

A check-up on these variations, has been thought desirable due to the fact that the previous studies had been made with a few young college students, trained for the work, rather than with persons of normal activities, age variations, and of both sexes. These requirements were satisfied by the excellent facilities for an extended study which were offered by a company whose general offices in Minneapolis are air conditioned and are occupied by 275 employees. The admirable arrangements for carrying on the desired survey included the following set-up and facilities:

(1) The office personnel consists of approximately 275 employees, including both men and women, having an age distribution of from slightly below 20 to 70 years, and other characteristics normally met with. A majority of these employees are between 20 and 40 years of age and about 55 per cent of the entire group are men.

(2) The offices are completely air-conditioned, and served by three separate systems. The control and recording equipment is unusually complete, each system having its own set of year-round automatic controls.

(3) Since the offices are under automatic temperature control from morning till night, there appeared to be an excellent opportunity to obtain data regarding the *shock effect* experienced by people when entering and the reaction experienced by people leaving summer cooled and air conditioned space.

(4) Minneapolis normally experiences one or two periods of hot weather during an average season. By starting early in the cooling season and continuing through this season until some degree of heating was required, it was expected that a study of the seasonal change in comfort requirements could be made.

In research of this type, wherein the reactions of a large group of people are involved, the method of initiating the work and approaching the subjects to acquaint them with the problems involved is of considerable importance. Realizing that many of the persons whose reactions were desired had no personal interest in air conditioning, it was thought that the actual work of collecting data should be preceded by bulletins acquainting them with the purpose of the study. The first bulletin, (reproduced herewith), sent to all employees of the company, was intended to produce an awareness on the part of the entire office personnel of the need and importance of the work contemplated.

BULLETIN No. 1. Subject: Air Conditioning Tests

The rapid growth of air conditioning is bringing our company an increasing amount of business, thus improving your condition of employment. At the same time it has imposed a tremendous and diversified responsibility upon all manufacturers of air conditioning apparatus including the related controls, and upon the engineering societies which are called upon to recommend proper conditions for human health and comfort.

The American Society of Heating and Ventilating Engineers has carried on research in Pittsburgh, Toronto, and Texas in an endeavor to determine the temperature and relative humidity conditions at which the largest percentage of people are comfortable and healthy during various times of the year. This work is of tremendous importance, since it provides the data necessary to make people comfortable and thus enhance the public acceptance of air conditioning.

Our company now has an opportunity to make an outstanding contribution to this field of knowledge. Because of the large group of persons employed in our air conditioned offices, and because of the complete control and recording facilities in the air conditioning equipment of these offices, we have been asked to cooperate in this work with the American Society of Heating and Ventilating Engineers by securing the comfort reactions of our office group.

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†Engineering Department, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

[1]Comfort Standards for Summer Air Conditioning, by F. C. Houghten and Carl Gutberlet. (A.S.H.V.E. TRANSACTIONS, Vol. 42, 1936, p. 215.)

[2]Cooling Requirements for Summer Comfort Air Conditioning, by F. C. Houghten, F. E. Giesecke, Cyril Tasker and Carl Gutberlet. (A.S.H.V.E. JOURNAL SECTION, *Heating, Piping and Air Conditioning*, December, 1936, p. 681.)

For presentation at the 44th Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, New York, N. Y., January, 1938.

We are, therefore, asking you to fill out a questionnaire, either daily or at other specified intervals. These questionnaires will be distributed and collected by some one designated for this task. Your recorded reactions will enable us to tabulate and analyse the group feelings. We cannot stress too highly that your personal unbiased feelings of warmth or chilliness are what is needed to make the work of greatest value.

Your cooperation in this work will be a distinct contribution to the necessary knowledge for more satisfactory air conditioning.

These bulletins were followed by a daily questionnaire card used for collection of the data and advice concerning the proper method of recording the individual daily reactions to the conditions in the office and the outside weather conditions. One of the cards was given to each employee each morning to be filled out during that day, and the following morning it was returned. One of the cards as returned is illustrated.

Daily Questionnaire to Office Personnel

Name _____

Location: *Zone 3*

Date: *May 27, 1937*

Insert in Proper Column, "W" for feeling of warmth, "C" for feeling of chilliness.

	IDEAL	MILD	SEVERE
1. Morning Reaction to Outdoors	*I*		
2. Reaction upon entering office. Duration: *10 min.*		*C*	
3. Reaction upon leaving for outdoors at noon. Duration: *5 min.* Reaction upon leaving for unconditioned space at noon; Duration:		*W*	
4. Reaction upon re-entering office at noon. Duration:	*I*		
5. General reactions during working hours: Time: 10:30 A.M.	*I*		
3:00 P.M.		*W*	
3:30 P.M.	*I*		
6. Initial Reaction during evening; Duration: *approximately 10 min.*		*W*	
7 Continued Reaction during evening			*W*

8 General Remarks: *Sunshine was uncomfortable at 3:00 P. M.*

By placing *I* in the *Ideal* column, line No. 1, this person indicated that upon leaving home in the morning he experienced an ideal feeling of warmth. When he entered the office, the *C* in the *Mild* column, line No. 2, shows that he felt mildly chilly for 10 min. At noon he went outdoors, and for 5 min felt mildly warm as indicated in the upper part of line No. 3. The lower part of line No. 3 would be used if he had gone to the unconditioned restaurant. When he re-entered the office his reaction was neither of warmth nor of chilliness, but one of ideal comfort as indicated by the *I* in line No. 4. In line No. 5 he indicates that at 10:30 A. M. he realized the office conditions were ideal, while at 3:00 P. M. he was mildly warm, as indicated by the *W* in column headed *Mild*. In line No. 6 this person has indicated that upon leaving the office at the close of work he experienced a mild feeling of warmth for a duration of 10 min. In line No. 7 he indicates by *W* in the *Severe* column that during the evening the feeling of warmth became severe. He explained under *General Remarks*, line No. 8, that his 3:00 o'clock feeling of warmth might be due to sunshine through the window.

It should be noted that the bulletins mentioned stressed the need for close cooperation and a clear expression of the feeling of those concerned. It is believed that this cooperation was obtained to a very marked degree throughout the entire test period.

Description of the Conditioning Systems

The conditioning apparatus supplying the offices is divided into three systems. The first of these supplies the south half of the sixth floor. The second is a zone system, supplying the north half of the fifth and sixth floors. The third system supplies the Engineering Department. The relative location of the spaces supplied by the three systems is evident in Fig. 1.

The first system consists of an air washer having a by-pass around the preheating coil, air washer sprays, and reheater coil. Provision is made for supplying outside air by means of a set of dampers located in an outdoor wall up-stream from the conditioning apparatus.

Precooling of the outdoor air in the second system is obtained by a finned surface cooling coil, located in the intake. There are dampers up-stream from this coil to provide a by-pass if necessary. The return and outdoor air is mixed in a plenum chamber up-stream from the fan. After passing through the fan, the air is divided into two streams, one of which passes over the finned surface cooling coil and the other passes over a finned surface steam coil. A water spray is supplied up-stream from the steam coil for humidification when necessary. Face dampers control the amount of air passing into either stream so that reheat is readily available. The air so conditioned is then again divided into two streams, one of which goes to the north half of the sixth floor and the other to the fifth floor.

System number 3, which supplies the Engineering Department, has precooling coils for the outside air, cooling or heating of the mixture of return and outdoor air, and suitable means for by-passing around either the heating or cooling coil.

Artesian well water at 52 F is used as the cooling medium in all three systems. After passing through the cooling coils, the water may be wasted to the sewer or sprayed over the roof, depending upon outside conditions. These systems are so controlled as to provide any desired conditions within the limits of the units themselves. There is an engineer in attendance at all times to care for any emergencies that might arise. It is possible by means of centrally located recorders to observe the condition of the air at any point in its passage through any one of the systems.

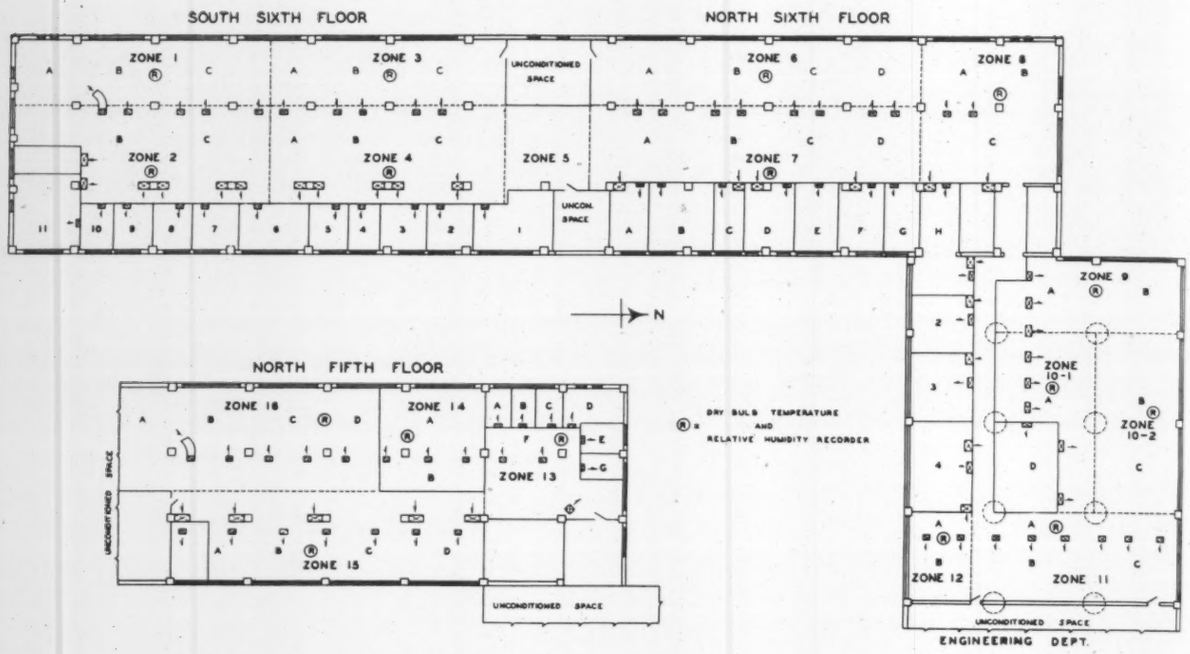


Fig. 1—Air conditioned office space in which the study was made

The Method of Obtaining Records of Physical Conditions

In a conditioned space as large as the general offices where studies were made, it was obviously necessary to group the occupants into zones in which the conditions were somewhat constant. This division was accomplished with no particular regard for occupant load by making observations of the dry-bulb temperature and relative humidity present at various times during the working day. These readings were made, one in approximately every 225 sq ft of floor space, with a standard sling psychrometer. After an analysis of this type it was relatively easy to divide the offices into zones with approximately constant conditions throughout. This division is shown in Fig. 1, the numbers referring to the zones and the letters within the zones serving to further sub-divide them for a more exact location of individuals.

There were no zones which were supplied by more than one system. It was felt that no ill effects would be experienced in zone number 5, the junction point of systems numbers 1 and 2. The layout of the conditioned space shows a large number of private offices, the occupants of which were away many times during the test period. At the beginning of the study three of the 16 zones were supplied with a dry-bulb thermometer and relative humidity recorder. In the other 13 zones observations were made of the wet- and dry-bulb temperatures by a sling psychrometer at three times each day as given:

8:05 to 8:50 A.M.—Entering the office.
12:30 to 1:15 P.M.—Re-entering the office.
3:40 to 4:25 P.M.—Leaving the office.

From the readings so obtained it was possible to get an idea of the trends in the various zones. It was seldom that any marked change occurred in these readings. When the remaining 13 recorders were received one was placed in each zone and the practice of daily observations discontinued except for the purpose of checking the calibration of each instrument.

The recorders were placed in such a position in each zone so as to be free from the effect of solar radiation, radiation from occupants, drafts, and other local interference. The approximate location of each recorder is shown in Fig. 1 by the letter *R*. The instruments were mounted on portable stands with the elements approximately 4 ft above the floor level. The glass cover of each instrument was painted to make the reading invisible to the occupants.

Method of Recording Data

Questionnaire cards of the type shown previously were distributed daily to each office employee, and the card for the preceding day was collected at the same time. Over 22,000 cards were collected in the study. The data from these cards were tabulated on ledger sheets to give a complete record of each individual's comfort reactions during the period of the study.

Question No. 5 of the questionnaire deals with the worker's reactions to the inside conditioned air after a short period following entrance, and it is therefore the only question concerning a person's reaction to the cooled space unaffected by entrance and leaving. This paper deals solely with this subject.

Questions 1, 2, 3, 4, 6 and 7 are concerned with the worker's reaction to the outside, the shock experienced by him upon entering the cooled space in the morning and at noon, the reaction experienced by him upon re-entering the outside at noon and after work, and his continued reaction to the outside during the off work hours. These questions will be made the subject matter of another paper being prepared for publication in the near future.

After the workers had gained experience in judging their feelings and reactions to air conditioning they were given a special questionnaire and requested to discuss more fully their general reactions to working in an air conditioned office and the general effect of this experience on their daily life as compared to their friends and associates who did not enjoy this privilege. The results of this special study are most interesting, and will be made the subject of a third report.

In obtaining the data, particularly that collected under question 5, it was at first thought desirable to avoid doing anything to bring to the worker's attention any undue consideration of his comfort reactions. It was at first assumed therefore that they were comfortable whenever they did not register some other feeling. Most desirable air conditions were occasionally upset until they were definitely uncomfortable, in an effort to secure the limits in temperature and humidity which were comfortable to people as a whole. This method of securing data appeared to have the advantage of not causing a person to become conscious of the surrounding conditions until he was uncomfortable. After proceeding for approximately 2 months on this basis, it was felt that possibly more intelligent answers to question number 5 could be had by asking the subjects to fill in their feelings at definite times. With this thought in mind, the person distributing and collecting the cards was instructed to circulate through the offices twice during the day and ask some workers to indicate their feelings. Approximately 35 different people each day were asked to supply this information. This procedure was followed until the completion of the study at the end of September.

It was also thought that by varying conditions in the three systems, it would be possible to obtain reactions over a wider range of air conditions. Since each system is under complete automatic control, it was readily possible to maintain quite widely different conditions with gratifying results.

Analysis of Test Results

A scale of feeling of warmth in which 4 represents ideal comfort, 3 and 5 comfortably cool and comfortably warm, respectively, 2 and 6 cool and warm, respectively, and 1 and 7 very cool and hot, respectively, has been used by the Research Laboratory over a period of years. In using this scale, it has been found that with untrained observers 3 and 5 are confusing, and they were eliminated from this study for that reason. In clarifying the meaning of the other numerical values in the scale to the workers, 4 was said to be ideally comfortable, 2 and 6 were called mildly cool or warm, and 1 and 7 severely cool and hot, respectively. The numerical values of 1, 2, 6 and 7 used in this study are therefore as nearly as can be evaluated the same as the same numerical values used in earlier studies. The numerical value of 4 used in this study may be said to be as nearly as possible equivalent to the three scale values of 3, 4 and 5 used in earlier studies. It is worthy of note that difficulty is always experienced in getting different persons to apply the same interpretation to their feelings. It may be assumed that the same interpretation is placed upon 4, or ideally comfortable, but that two different people may place different interpretations on mildly or severely cool.

A typical set of data collected on August 31 are plotted in Fig. 2. Each point represents the feeling expressed as 1, 2, 4, 6 and 7, discussed above, and plotted against the effective temperature in the particular zone in which the occupant was located at some time during this day. The many points for a given feeling at a certain effective temperature are grouped around a given ordinate line. The number of points does not make it possible to group them all on a given horizontal line. The group is indicated, however, as applying to this line, without any attempt to express fractional degrees of feeling. The expressions of comfort of the men are indicated below any ordinate line, while the expressions of women are indicated above, and the different age groups are indicated by the symbols noted.

Inspection of the entire plot, including all points for all age groups and for both sexes, indicates a maximum expression of ideal comfort, or 4, at 70.5 deg effective temperature, with larger percentages indicating 6 or 7 for higher temperature, and a greater feeling of coolness for lower temperature. The effective temperature for maximum comfort may also be determined by reference to the tabulated data, giving a percentage indicating various degrees of comfort at the top of the chart. This will indicate optimum comfort at approximately 70.5 deg effective temperature.

A statistical analysis of the same data for August 31 indicates that with perfect sampling optimum comfort should be had at 71.5 deg effective temperature. The variation in the effective temperature for optimum comfort with different methods of analysis is quite typical of all the data analysed. While the variation is of academic interest, it is not of any great significance on most days. Undoubtedly, the statistical analysis gives indications nearer the true values, and was used on most of the data.

The data collected on each day on which observations were made between May 20 and September 30 are plotted in the upper part of the chart in Figs. 3 and 4, parallel with the log of the normal, minimum, maximum, mean and 9 o'clock daily temperatures for the same pe-

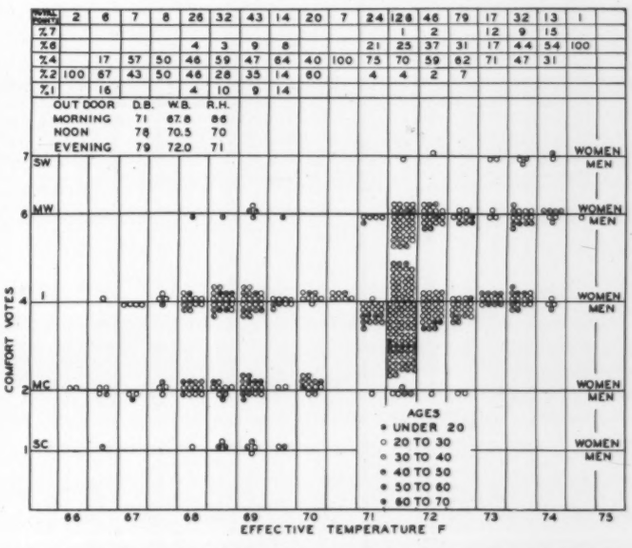


Fig. 2—Sample of daily plotted data for August 31 showing relation between the effective temperature maintained and (I) 4 ideally comfortable, (II) 2 mildly cool, (III) 6 mildly warm, (IV) 1 severely cool and (V) 7 severely warm

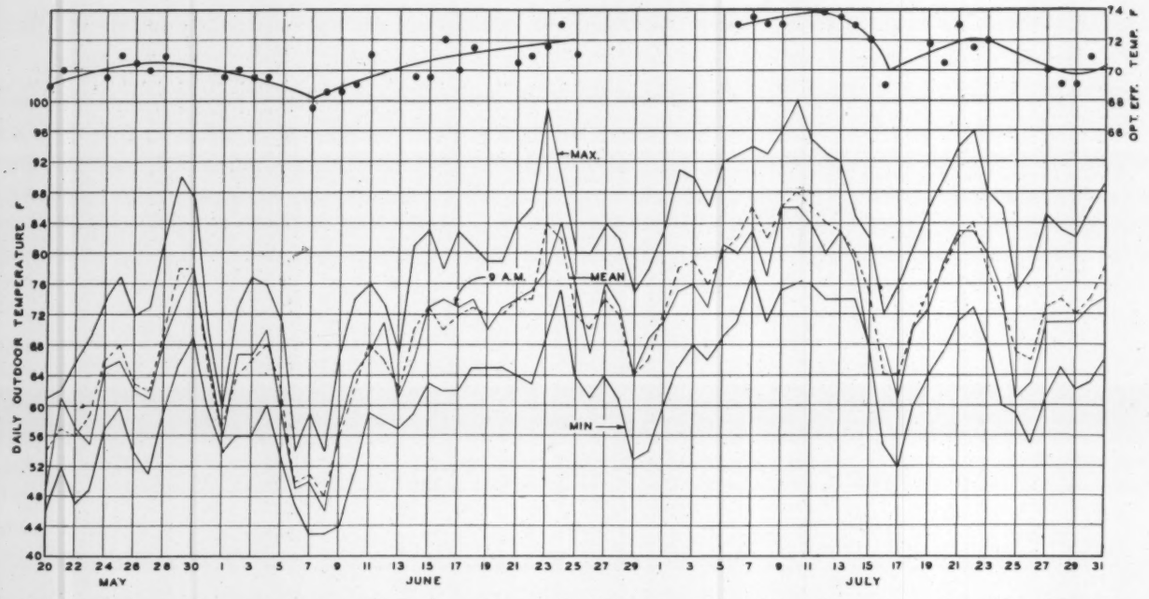


Fig. 3—Daily outdoor temperature log and optimum effective temperature for indoor air conditioning. May 20 to July 31, 1937

riod. For the data collected up to and including July 31, the several zones conditioned by the different systems were all operated with a view of giving maximum comfort without reference to the study. Naturally during the days when these reactions were plotted, as in Fig. 2, they did not spread out over as many degrees of effective temperature from right to left, and as a result, the effective temperature for optimum comfort could not be determined with the same degree of certainty. For the period August 1 to September 30, occupants in the different zones, or at different times within the same zone, were given a range of effective temperatures designed to give a greater spread when plotted as in Fig. 2. The variations in effective temperature for optimum comfort for this latter period in the summer are therefore somewhat more significant than for the earlier period.

Variation in optimum effective temperature for comfort with time and therefore weather conditions are of great interest. The data for May and that for the latter half of September indicate a positive desire for a somewhat lower effective temperature in indoor air conditioned space. A range of from 69 to 71 deg effective temperature for May is indicated, while for the most of July and August an effective temperature range of from 69 to 74 deg is indicated. Daily variations are not very great, but a close inspection indicates some variations with changing weather, thus indicating a desire for a little lower effective temperature indoors during a cold spell, as from June 5 to 9, for the latter part of September, and other short periods, when indoor effective temperatures as low as 67 deg were desired. Likewise, high indoor effective temperatures were desired on or after

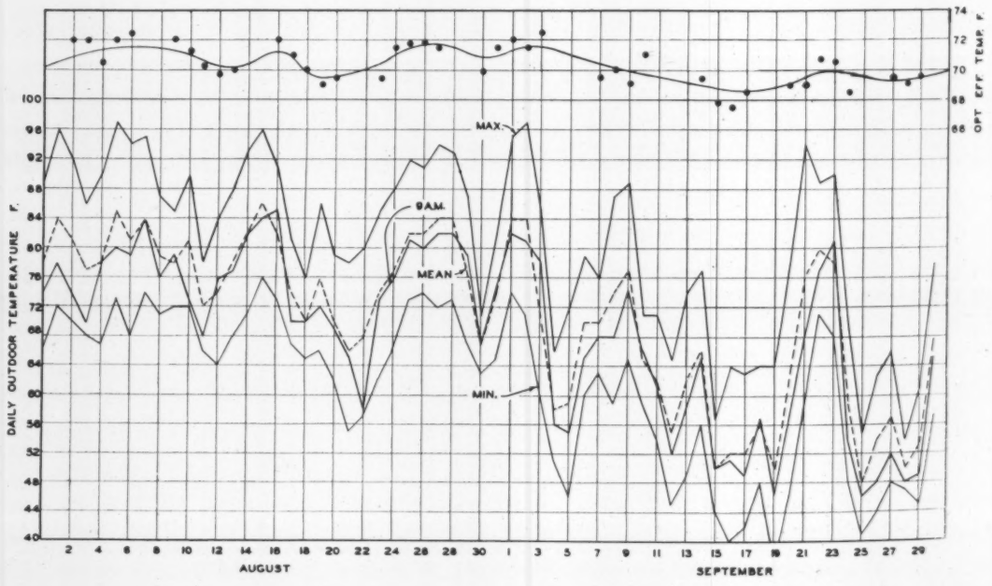


Fig. 4—Daily outdoor temperature log and optimum effective temperature for indoor air conditioning. August 1 to September 30, 1937

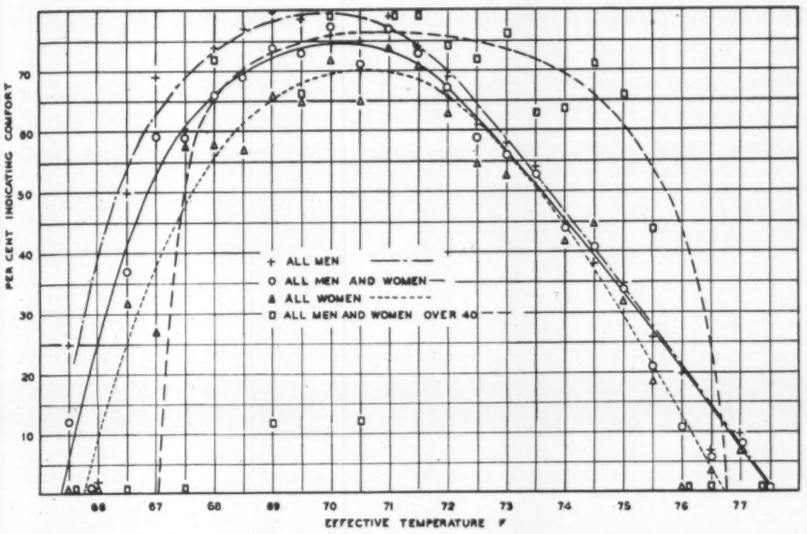


Fig. 5—Relation between effective temperature maintained in conditioned space and percentage of observations indicating comfort for period August 2 to September 3, 1937. Curve for all men and women under 40 coincides with curve for all men and women

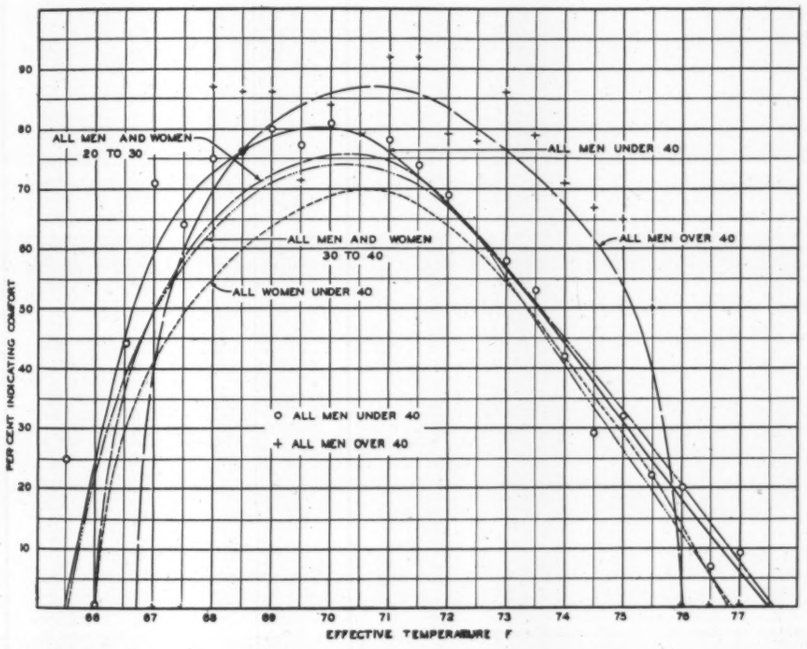

PER CENT INDICATING COMFORT
ALL MEN AND WOMEN 20 TO 30
ALL MEN UNDER 40
ALL MEN AND WOMEN 30 TO 40
ALL MEN OVER 40
ALL WOMEN UNDER 40
O ALL MEN UNDER 40
+ ALL MEN OVER 40
EFFECTIVE TEMPERATURE F

Fig. 6—Relation between effective temperature maintained in conditioned space and percentage of observations indicating comfort for age and sex groups. Period: August 2 to September 3, 1937

very hot days on June 23, July 10 and July 22. It is significant that the highest indoor condition was at times desired on the day following maximum outside weather conditions. This variation is, however, not as great as many authorities have suggested, and does not follow closely variations in weather conditions. A maximum variation during July and August, which may be ascribed to variations from cool to hot spells, would seem to be about 5 deg, or from 69 to 74 deg effective temperature.

The data for any one day do not permit a very satisfactory determination of any variation of a desired optimum effective temperature for different age or sex groups, or for variation in indoor effective temperature with outdoor conditions. These variations are better shown for groups of data covering different periods, as in Figs. 5 to 7. In Fig. 5 are plotted all the observations of comfort for a period from August 2 to September 3 as percentages of those feeling comfortable at the various effective temperatures. This chart is based upon approximately 700 votes for any one effective temperature. With this great mass of data the variation in percentage of comfort for any effective temperature maintained is quite definite.

These curves indicate that men show a maximum of about 80 per cent of comfort at 70 deg effective temperature, while women show a maximum of about 70 per cent comfortable at approximately 70.6 deg effective temperature, while the entire group indicates optimum comfort at about half-way between these two extremes. This variation between men and women of all age groups is typical and is the same for all groups analysed.

The optimum effective temperature for comfort for different age groups could not be determined with the same certainty as that for all men and all women plotted in Fig. 5. However, these relationships could be determined for a somewhat lesser degree of accuracy, and they are plotted in Fig. 6.

In order to show the variations in effective temperature desired in the late spring, mid-summer, and early fall, the percentage showing maximum comfort for different effective temperatures for periods from May 20 to June 10, for July, August, and for September, are plotted in Fig. 7. It will be noted in reference to the weather log in Figs. 3 and 4 that these are periods of somewhat different average weather conditions. Optimum effective temperatures ranging from about 69 to 68 are indicated for May and September, and 71.5 and 70 deg for July and August, respectively. Inspection of the plotted data at the top of Figs. 3 and 4, however, indicates that on hot days optimum comfort may be had at as high as 74 deg effective temperature.

The variation in the effective temperature for optimum comfort plotted at the top of Figs. 3 and 4 indicates some relationship with weather conditions. In order to bring out this relationship, the optimum effective temperature for different days is plotted against minimum and maximum daily temperatures in Fig. 8, daily mean temperatures in Fig. 9, and the average mean temperature for a given day and the two previous days in Fig. 10. These three charts show that a relationship exists between the optimum effective temperature and

the four daily weather conditions against which they are plotted. Table 1 shows the different weather conditions at which effective temperatures of 68, 70 and 73 deg are indicated from the medium curve from each plot, and the number of degrees plus or minus tolerance which appears to be allowable in each instance.

It may be of interest to demonstrate the application of the statistical method of analysis of this type of data as used in this paper. In statistics a set of observations is considered a sample drawn from a parent population of possibly infinite size. If this sample is not too small and is selected in a manner that insures randomness, the probability that it is representative is good and can be calculated.

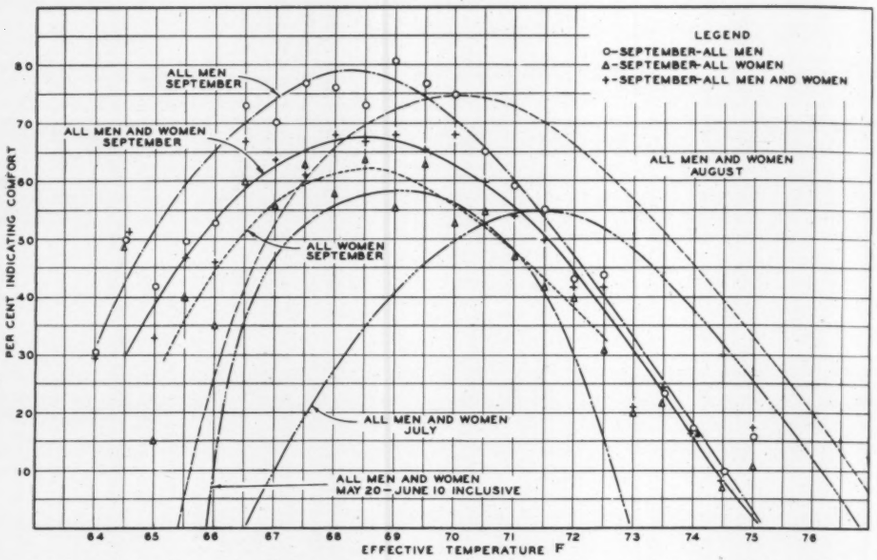


Fig. 7—Relation between effective temperature maintained in conditioned space and percentage of observations indicating comfort for various sex groups and periods. May 20 to September 30, 1937

When individual measurements are repeated in a set of observations the result is a frequency. A set of comfort votes over a range of effective temperatures is an example of a frequency table, with the number of votes for each effective temperature a single frequency. In such cases it will be observed that a representative frequency curve of any particular sample takes a mound shape, often termed a *cocked hat*. It follows, therefore, that the comfort data approximates the normal curve:—

$$y = C\,e^{-h^2 x^2} \qquad [1]$$

where:

e = the base of the natural or Naperian logarithms (2.71828)

C = a constant which determines the height of the curve, and

h = a constant which determines the spread.

This normal curve, because it is symmetrical, furnishes a basis for the determination of the accurateness of fit of any mound-shaped curve, whether it be badly skewed to either side, flattened out or peaked at the top. For these reasons it is also possible to calculate, with a definite probability, the expected frequencies of the parent population from the frequencies of the observed sample.

The maximum frequency is known as the *mode*. It should not be confused with the mean frequency (arithmetic mean). The mode for any comfort frequency chart is that particular frequency which is greatest, while the arithmetic mean frequency is the sum of the frequencies divided by the number of observations. There are a number of methods by which the mode for each comfort sample can be determined. An approximation can be obtained using the fact that the second degree equation:

$$ax^2 + bx + c = 0 \qquad [2]$$

is a maximum, *when*

$$x = -\frac{b}{2a} \qquad [3]$$

This approximation can be checked by calculating the expected frequencies of the parent population and has a special value when, as with a number of samples in the data, it is particularly difficult to determine the true mode. In this connection, it is desirable to point out that no mechanical process, such as statistics, can take into account all of the facts. In the case under consideration, after the mode was determined, the data for each sample were examined carefully. A few instances were found where a number of votes fell on the cold side of the comfort zone. It was evident, then, that the approximate mode calculated was not the true mode and adjustment was accordingly made.

A further check was applied in the determination of the true mode. This check also furnished the expected frequencies of the parent population. Because many of the samples involved a small number of observations, the Poisson Exponential Series was used for this purpose. It consists of the expansion:

$$e^{-m} + m\,e^{-m} + \frac{m^2}{\underline{|2}}\,e^{-m} + \frac{m^3}{\underline{|3}}\,e^{-m} + \qquad [4]$$

Table 1—Outside Weather Conditions Requiring Indoor Effective Temperatures of 68, 70 and 73 Deg

Weather Condition	Outside Temperature for Indoor Requirements of:			Plus or Minus Tolerance for Indoor Effective Temperatures
	68 Deg	70 Deg	73 Deg	
Minimum dry-bulb temp.—F	48	59	77	1.5 F
Maximum dry-bulb temp.—F	68	79	95	2.0 F
Daily mean dry-bulb temp.—F	51	67	91	1.2 F
Three day average, including that considered and the two previous days	49	66	91	1.5 F

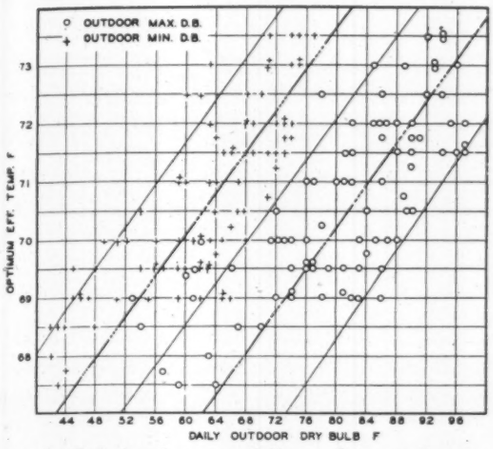


Fig. 8—Relation between daily outdoor maximum and minimum dry-bulb temperature and optimum effective temperature

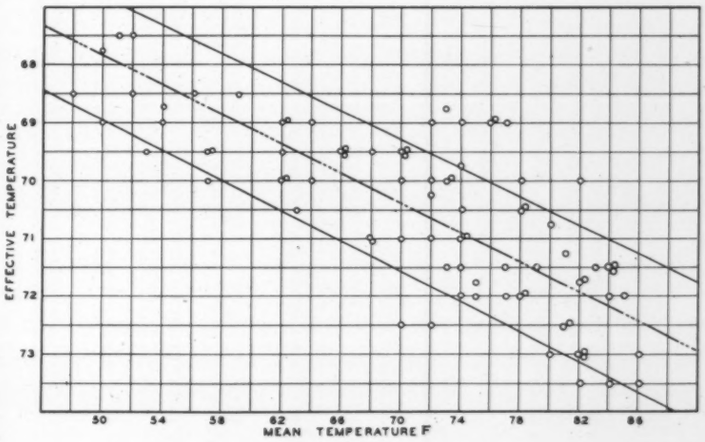


Fig. 9—Relation between daily mean dry-bulb temperature and optimum effective

in which each term furnishes a frequency. Here e is the base of the natural logarithms and m is an exponent so chosen that the maximum expected frequency will occur for the effective temperature of the calculated mode. When the expected frequencies are plotted it is possible to check the mode previously obtained. For an example, take the total ideal comfort data on both men and women for a period in August. These observed effective temperatures and votes are shown in Table 2. The total number of observations are 26 but, by inspection, it is evident that at least three are vacant. The temperatures advance in steps of ½ deg. Therefore, the mean (m) can be taken as 10.5. Inserting this value for m in the first term of the Poisson equation gives a value of 0.00001 for e^{-m}. Inserting the values for m and e^{-m} in the Poisson equation gives for the successive terms the values shown in the Table, under the heading *Exponent Values*. The sum of the exponent values (0.27979), divided into the sum of the observed votes gives the factor 20683. When this factor is multiplied by each of the exponent values the expected votes for the parent population, shown in Table 2 are obtained. These votes have a sum equal to that for the observed votes in order that the accurateness of fit, at any point on the curve for ideal comfort (see Curve A in Fig. 11), can readily be observed. In the same manner, curves B and C, representative of cool and warm conditions, are also obtained. With the total expected votes for each effective temperature obtained from the calculations for curves A, B and C, it is now possible to figure the percentage expectancy in votes for ideal comfort conditions as shown in curve D.

Table 2—Tabulations for Poisson Series Calculations

Effective Temperature	Observed Votes	Exponent Values	Expected Votes
65.5	1	.....	0
66.0	0	.....	0
66.5	13	0.00011	3
67.0	70	0.00050	11
67.5	38	0.00170	34
68.0	164	0.00470	91
68.5	264	0.00890	167
69.0	306	0.01550	286
69.5	322	0.02350	428
70.0	549	0.03150	570
70.5	292	0.03690	685
71.0	707	0.03950	744
71.5	608	0.03710	689
72.0	676	0.03200	591
72.5	453	0.02500	472
73.0	557	0.01900	355
73.5	226	0.01350	250
74.0	281	0.00850	167
74.5	133	0.00550	106
75.0	92	0.00325	63
75.5	21	0.00190	37
76.0	6	0.00090	20
76.5	3	0.00050	11
77.0	4	0.00023	5
77.5	0	0.00010	2
78.0	1	.....	0
	5,787	0.27979	5,787

Discussion of Results

The question of effective temperature requirements for air conditioning for different periods of the year has been the subject of intensive study since 1920. The early part of this work clearly demonstrated about 66 deg Effective Temperature as optimum for winter heating and air conditioning. More recent work on the requirements for summer cooling and air conditioning has indicated from 68 to 71 deg effective temperature desired in the Toronto district, 69 to 74 deg effective temperature in Pittsburgh, and 71 to 74 deg effective temperature for College Station, Texas. These studies, made over the previous two summers, indicated a tentative conclusion for an optimum effective temperature for summer air conditioning of about 73 deg for Pittsburgh and any warmer climate, and about 71 deg for Toronto.

These studies gave no measurable indication of any variation in the daily requirement depending upon outside weather conditions. It was thought that the current study in Minneapolis, started in the spring and carried on until the fall, would clear up this question.

The daily requirements plotted in Figs. 3 and 4 should go a long way toward narrowing down the room for doubt and controversy. They do not, however, closely demonstrate a definite effective temperature as applying without question throughout the cooling season. They do indicate some requirement for changing the indoor condition with violently changing outdoor weather conditions. The data for July and August show a maximum variation in desired indoor conditions from 69 to 74 deg effective temperature, or about the same range as concluded from last year's study for Pittsburgh. If, however, the indicated points in Figs. 3 and 4, for days when the outside mean temperature was 75 deg or lower, are eliminated, the total variation comes between

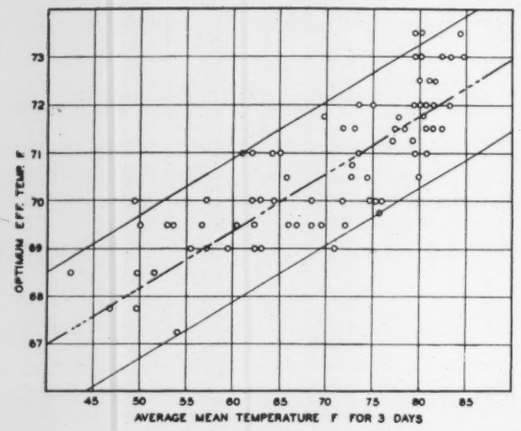


Fig. 10—Relation between the average mean dry-bulb temperature for a given day and two previous days and optimum effective temperature

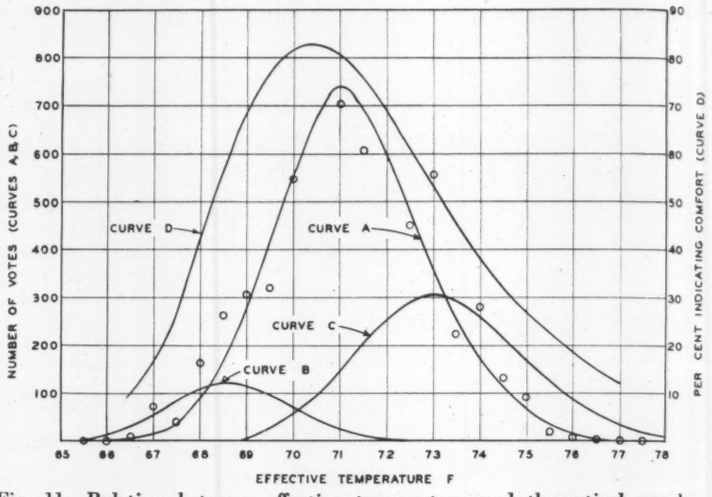


Fig. 11—Relation between effective temperature and theoretical number of people voting: Comfortable, Curve A; warm, curve C; and cool, Curve B. (Points on Curve A, actual observed). Curve D shows theoretical per cent voting comfortable

70 and 74 deg effective temperature. Since it is probable that in most cases heating would be required to maintain an indoor temperature above 69 or 70 deg when the outdoor mean was 75 deg or below, the provision for lowering indoor temperatures on these cool days should automatically take care of itself.

Experience gained at the Research Laboratory in its many studies indicates that a trained person is sensitive to a temperature variation of plus or minus 1 deg, but it is doubtful if a person not trained for such observation is sensitive to much less than plus or minus 2 deg; or at least, it may be said that a variation of plus or minus 2 deg is not a very important factor in a person's comfort. This reasoning would indicate that a continuous indoor condition giving 72 deg effective temperature in Minneapolis during the summer cooling season should give satisfaction, except during extremely cool spells, when the indoor temperature would automatically drop low enough to take care of itself, if artificial heating was not provided.

Hence, this study would seem to indicate the desirability of maintaining about 72 deg effective temperature throughout the cooling season in Minneapolis, with a drop to about 70 deg during May and June, and the latter half of September. Such a recommendation would differ by about 1 deg from the conclusions drawn from the earlier Laboratory studies[3] for Pittsburgh and Texas, which indicated a continuous indoor temperature of 73 deg throughout the cooling season. As pointed out in the earlier studies, the choice of a high indoor requirement within the allowable range of effective temperatures should serve both toward increased economy in cooling and to reduce the shock effect upon entering the cooled space. While such a recommendation would apparently give a condition slightly too high on some days when cooling is required in Minneapolis, it is doubtful if it would result in much discomfort for that reason, and therefore would serve toward increased efficiency in cost of operation and tend to decrease the cold shock effect.

[3]Loc. Cit. See Notes 1 and 2.

Acknowledgment

The authors wish to acknowledge the guidance and assistance rendered by M. C. W. Tomlinson in helping to analyze statistically the great mass of data, which have added greatly to the value of the paper.

The Research Technical Advisory Committee on Comfort Air Conditioning is indebted to the Minneapolis-Honeywell Regulator Co. for their cooperation in providing the facilities of their general office building and the necessary personnel to observe and collect the data for these investigations, and to the Brown Instrument Co. for furnishing the recording instruments used in these studies.

Elected to Life Membership

J. D. Hoffman
West Lafayette, Ind.
Elected 1903

H. C. Meyer, Jr.
New York, N. Y.
Elected 1898

J. H. Kitchen
Kansas City, Mo.
Elected 1906

J. N. Russell
London, England
Elected 1899

J. F. Hale
Chicago, Ill.
Elected 1902

B. C. Davis
Elmira, N. Y.
Elected 1904

A. S. H. V. E. RESEARCH

A Page of News Notes and Comment

By **Brewster S. Beach***

RESEARCH COMMITTEE ORGANIZING "SPECIAL PROJECT" PROGRAM FOR 1938

W. A. Danielson, Chairman, A. S. H. V. E. Committee on Research

In furtherance of the plan to assemble reports on current research projects as the basis of inviting contributions from special industrial groups for the support of specific investigations, W. A. Danielson, chairman of the Committee on Research, has asked the chairmen of the technical subcommittees for the following information, with the aid of which it is proposed to develop a partially self-supporting research program for 1938:

(1) Details of research that should be done in 1937.

(2) Estimate of 1938 cost and for completion of the study.

(3) Location of actual research.

(4) Personnel involved.

(5) What industry will be interested in bearing the cost and what executives should be approached for personal contact.

In his communication to technical chairmen, Colonel Danielson says: "Experience indicates that it will be easier to finance particular studies than to attempt to collect funds for the work generally. The successful experience of the Glass Committee in raising a substantial amount indicates the possibility of financing special studies."

A meeting of the Research Executive Committee will be called this month to consider the suggestions being made.

RESEARCH PUBLICITY PROGRAM

Air Conditioning For Health

Air conditioning is generally considered to be concerned mainly with comfort, but engineers and scientists now see the industry on the threshold of developments likely to have a profound effect on sociological, public health and medical problems. To discover what this effect may ultimately be and to take full advantage of its possible influence on health many of the scientists of the Committee on Research of the American Society of Heating and Ventilating Engineers are making numerous studies in all phases of air conditioning. They aim to find just what are the fresh air needs of the normal person, why stale air is obnoxious and unhealthful, and how air conditioning may be used by the medical profession. The field that is being given most consideration today is the medical field.

It has been found already that air conditioning is the most reliable and safest method for artificially raising body temperatures with complete protection against burns. Such raising of body temperature is necessary in the so-called "fever box" treatments of certain diseases. Research is now going on which may uncover the causes or reasons for the curative quality of the air in tubercular centers such as Arizona and make possible duplication by air conditioning in eastern sanitariums. Air conditioning may also find ultimate use for the effect of high temperature and high humidity on the insane instead of the commonly used high temperature water baths. Air conditioning in the operating room, clinics, and recovery wards may also become realities as a result of present studies.

Hundreds of newspapers and magazines are carrying educational news about A. S. H. V. E. Research. Above is a typical example from the Tampa, Fla., *Tribune*, based on an article in the *Scientific American* describing the Society's activity in studying physiological aspects of air conditioning. This is part of an educational program to interpret A. S. H. V. E. activities to the public. Publicity to date has gained a circulation of more than 10,000,000

COOPERATION BETWEEN MEDICAL MAN AND ENGINEER STRESSED

Dr. Thomas R. Thorburn

The need of cooperation and research between the medical and engineering professions was stressed in a recent address by Dr. Thomas R. Thorburn, D. O., M. D., assistant surgeon of the New York Ophthalmic Hospital and head of Ear, Nose and Throat Department of Osteopathic Clinic, before the New York Chapter of the Society on What Patients Tell Their Doctors About Air Conditioning.

Making the point that the engineering profession is every year being linked more closely with the healing arts, Dr. Thorburn emphasized the need of closer understanding between the science of air conditioning and that of medicine. Air conditioning practice, he said, has established certain standard atmospheric conditions to which the public must become adapted in order to extract the greatest benefits, and this requires a vast amount of educational work both on the part of the physician and the engineer.

Stressing the importance of *shock* between indoor and outdoor temperatures during winter months as of greater significance to health than the cold shock experienced when entering an air conditioned space in summer, Dr. Thorburn saw air conditioning in a position to wield an influence upon dress and diet.

He cited as an example of the latter the inclination to eat more and heavier foods in air conditioned restaurants in summer because of the comfort conditions, but pointed out that this often accentuated the feeling of discomfort when emerging from such conditioned places because metabolism was increased and the body less able to quickly adapt itself to a change of atmospheric conditions.

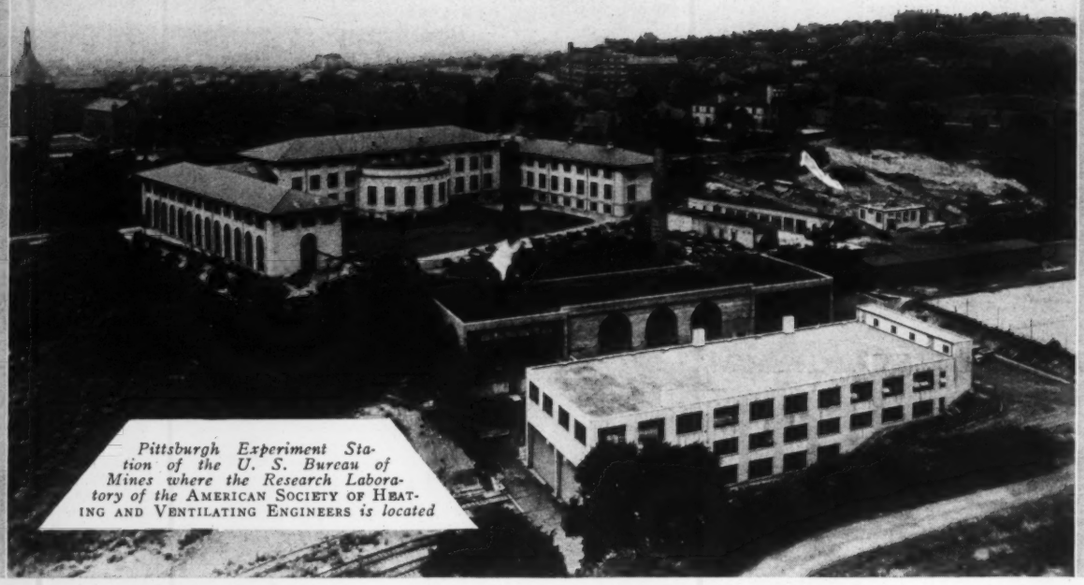
Dr. Thorburn made a special plea for education along the lines of teaching the public to realize that most complaints of harmful effects from air conditioning come from persons suffering from some inherent physical deficiency or surrounded by a harmful psychological environment. The average normal person is perfectly immune to such effects, he concluded.

CURRENT NEWS NOTES

Albert J. Nesbitt, of J. J. Nesbitt, Inc., has recently been appointed Research Representative for the Philadelphia Chapter.

Walter L. Fleisher, Vice-Chairman of the Committee on Research, attended a meeting of the Air Conditioning Committee of the *American Gas Association* on November 23 to consider problems connected with the promotion of gas in summer air conditioning. His suggestion that the research laboratory of the A.S.H.V.E. undertake a cooperative investigation of comfort reactions in the range of lower humidities available to gas operated equipment was commented on favorably and taken under consideration by the *A.G.A.* committee.

*Director, Information Service, Committee on Research.



Pittsburgh Experiment Station of the U. S. Bureau of Mines where the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS *is located*

COMMITTEE ON RESEARCH

W. A. DANIELSON, *Chairman;* W. L. FLEISHER, *Vice-Chairman;* F. C. HOUGHTEN, *Director;* DR. A. C. WILLARD, *Technical Adviser;* A. C. FIELDNER, *Ex-Officio Member. One year:* C. A. DUNHAM, W. L. FLEISHER, ELLIOTT HARRINGTON, A. P. KRATZ, H. C. MURPHY. *Two Years:* W. A. DANIELSON, C. E. LEWIS, D. W. NELSON, C. TASKER, C.-E. A. WINSLOW, *Three Years:* H. E. ADAMS, A. E. STACEY, G. L. TUVE, J. H. VAN ALSBURG, J. H. WALKER.

Executive Committee: W. A. Danielson, *Chairman;* W. L. Fleisher, J. H. Walker.

Technical Advisory Committees

Committee on Air Cleaning—IP-4: H. C. Murphy,* *Chairman;* M. I. Dorfan, C. E. Lewis,* S. R. Lewis, G. W. Penney, A. L. Simison, W. O. Vedder.

Committee on Air Conditioning Requirements of Glass—IF-18: M. L. Carr, *Chairman;* F. L. Bishop, A. N. Finn, E. H. Hobbie, R. J. Lillibridge, R. A. Miller, F. W. Parkinson, W. C. Randall, L. T. Sherwood, J. T. Staples, C. Tasker,* G. B. Watkins, F. C. Weinert.

Committee on Air Distribution—IP-21: Ernest Szekely, *Chairman;* S. H. Downs, M. K. Fahnestock, F. J. Kurth, D. W. Nelson,* C. H. Randolph, J. E. Schoen, G. L. Tuve,* J. H. Van Alsburg.*

Committee on Air Friction—IP-6: J. H. Van Alsburg,* *Chairman;* C. A. Booth, S. H. Downs, C. M. Humphreys, R. D. Madison, L. B. Miller, L. G. Miller.

Committee on Atmospheric Impurities and Resulting Safety and Health Requirements—IP-26: Theodore Hatch, *Chairman;* J. J. Bloomfield, C. A. Booth, Philip Drinker, Dr. Leonard Greenburg, Elliott Harrington,* H. B. Meller.

Committee on Climate and Air Conditioning—C-24: Dr. C. A. Mills, *Chairman;* Major G. C. Dunham, James Govan, Dr. W. J. McConnell, C. F. Neergaard, Dr. F. M. Pottenger, Jr., E. L. Weber, Prof. C.-E. A. Winslow.*

Committee on Comfort Air Conditioning—OH-22: C. Tasker,* *Chairman;* A. E. Beals, F. R. Bichowsky, Thomas Chester, F. E. Giesecke, Elliott Harrington,* R. E. Keyes, A. B. Newton, C. P. Yaglou.

Committee on Cooling Load in Summer Air Conditioning—IP-30: J. H. Walker,* *Chairman;* C. M. Ashley, John Everetts, Jr., F. H. Faust, H. F. Hutzel, L. S. Morse, A. E. Stacey, Jr.,* and R. M. Strikeleather.

Committee on Corrosion in Air Conditioning Equipment—IF-14: A. E. Stacey, Jr.,* *Chairman;* A. F. L. Anderson, M. L. Diver, F. L. LaQue, C. E. Lewis,* R. M. Palmer, F. N. Speller, C. M. Sterne, R. T. Thornton, I. H. Young.

Committee on Corrosion in Steam Systems—IF-2: A. R. Mumford, *Chairman;* J. F. Barkley, C. A. Dunham,* T. J. Finnegan, R. R. Seeber, F. N. Speller, C. M. Sterne.

Committee on Effect of Water on Roofs—IF-29: A. B. Snavely, *Chairman;* M. R. Beasley, J. B. Griffiths, Elliott Harrington,* E. H. Hyde, W. L. Murray, E. R. Queer, C. S. Reeve, E. T. Selig, Jr.

Committee on General Air Conditioning Comfort Requirements—OH-5: C. P. Yaglou, *Chairman;* J. J. Aeberly, R. R. Sayers, C.-E. A. Winslow.*

Committee on Heat Requirements of Buildings—IF-8: O. W Armspach, *Chairman;* P. D. Close, W. H. Driscoll, H. M. Hart, V. W. Hunter, H. H. Mather, E. C. Rack, F. B. Rowley, R. J. J. Tennant, J. H. Walker.*

Committee on Heat Transfer of Finned Tubes with Forced Air Circulation—IP-10: F. B. Rowley, *Chairman;* H. F. Hutzel, R. H. Norris, C. H. Randolph, W. E. Stark, G. L. Tuve,* C. F. Wood.

Committee on Insulation—IF-23: L. A. Harding, *Chairman;* E. A. Allcut, H. C. Bates, H. C. Dickinson, J. D. Edwards, E. C. Lloyd, W. E. McMullen, R. T. Miller, E. R. Queer, T. S. Rogers, F. B. Rowley, W. S. Steele, C. Tasker,* B. Townshend, G. B. Wilkes.

Committee on Intermittent Heating—IP-20: E. K. Campbell, *Chairman;* W. L. Cassell, Prof. E. F. Dawson, N. W. Downes, F. E. Giesecke, J. M. Robertson, J. H. Kitchen, Prof. A. H. Sluss, G. L. Tuve.*

Committee on Psychrometry—C-11: F. R. Bichowsky, *Chairman;* C. A. Bulkeley, J. A. Goff, Dr. E. V. Hill, F. G. Keyes, A. P. Kratz,* W. M. Sawdon.

Committee on Radiation with Gravity Air Circulation—IP-9: M. K. Fahnestock, *Chairman;* B. C. Benson, H. F. Hutzel, J. P. Magos, J. W. McElgin, J. F. McIntire, D. W. Nelson,* R. N. Trane, T. A. Novotney.

Committee on Relation of Body Changes to Air Changes—OH-3: Dr. E. V. Hill, *Chairman;* N. D. Adams, J. J. Aeberly, John Howatt, A. P. Kratz,* P. J. Marschall, V. L. Sherman.

Committee on Sound Control—IF-1: J. S. Parkinson, *Chairman;* C. M. Ashley, G. F. Drake, V. O. Knudsen, R. F. Norris, C. H. Randolph, J. P. Reis, A. E. Stacey,* G. T. Stanton, F. R. Watson.

Committee on Summer Air Conditioning for Residences—IP-7: M. K. Fahnestock, *Chairman;* E. A. Brandt, John Everetts, Jr., Elliott Harrington,* H. F. Hutzel, E. D. Milener, K. W. Miller, E. B. Newill, F. G. Sedgwick, J. H. Walker.*

Committee on Transportation Air Conditioning—C-12: L. E. Miller, *Chairman;* T. R. Crowder, F. B. Rowley, A. E. Stacey, Jr.,* L. W. Wallace.

Committee on Treatment of Air with Electricity—C-17: Prof. C.-E. A. Winslow,* *Chairman;* R. D. Bennett, W. H. Carrier, L. W. Chubb, Major W. D. Fleming, R. F. James, L. R. Koller, Dr. C. A. Mills, Prof. E. B. Phelps, Prof. G. R. Wait, Prof. W. T. Wells.

Committee on Weather Design Conditions—IF-31: W. E. Stark, *Chairman;* E. W. Goodwin, A. C. Grant, J. H. Kincer, A. P. Kratz,* L. S. Ourusoff.

*Member of Committee on Research.

Correlating Thermal Research

As a part of the efforts of the A. S. H. V. E. Research Laboratory to correlate research in thermal engineering carried on by the many institutions engaged in such work, and to disseminate the published results of such studies together with other reports of progress in the field, and in order to make this information available to the membership of the Society, there will be published monthly on this page a limited number of brief abstracts of articles which it is believed will be of interest to all concerned. For more complete lists address the Librarian, A. S. H. V. E. Research Laboratory, U. S. Bureau of Mines Experiment Station, Pittsburgh, Pa.

F. C. Houghten, *Director*.

W. A. Danielson, *Chairman*.
COMMITTEE ON RESEARCH

• World's Cleanest Air in Chicago Building, by H. W. Tenney. *Refrigerating Engineering*, vol. 34, no. 5, Nov. 1937, pp. 299-301. Efficiency of electrostatic process for removing dust particles from the air, as installed in the Field Building, Chicago. 99 per cent of all particles, by weight, are removed from air, including cigarette smoke particles and pollen.

• Status of Our Knowledge of Coal Selection for Steam-Generating Equipment, by R. A. Sherman, *Mechanical Engineering*, vol. 59, no. 11, Nov. 1937. "Enough information is available on all of the coals mined in the U. S. and the effect of their characteristics on the performance of all types of equipment that, if that knowledge were applied in each installation, coal selection would be narrowed down to a few sample coals." The paper gives general information on various kinds of coal and on various types of stokers.

• Selecting Heating Equipment for a Large Suburban Housing Development, by Robert Thulman. *Heating and Ventilating*, vol. 34, no. 10, Oct. 1937, pp. 41-44. Description of heating systems in Resettlement Administration town of Greenbelt, Md. Heating cost reduced by reduction of the heat requirements by good construction, with special reference to wall, roof and window construction, and to the efficient use of fuel.

• Electric Power Markets in Washington, by Carl Edward Magnussen. Washington Engineering Experiment Station, University of Washington, Seattle, Wash., *Bulletin no. 93*. Electric heating of residences may be a major factor in the power industry in the Northwest. Economical use of electric heating depends upon climatic factors and power rates. Electric power rates higher than ½c per kwhr prohibit economical use of electric energy for residence heating.

• Date Heating Season Begins and Ends in Normal Year. *Heating and Ventilating*, vol. 34, nos. 10 and 11, 1937. Oct. 1937, p. 45 and Nov. 1937, p. 44. Discussion of date heating season begins and ends in various sections of U. S., showing effect of mountains and atmospheric humidity effects on climate. Data from 100 cities. Map of U. S. showing sections having same beginning dates for heating season and map showing same dates for end of heating season.

• Note on Comparative Tests Made with the Hatch and the Greenburg-Smith Impingers, by J. M. DalleValle. U. S. Treasury Department, *Public Health Reports*, vol. 52, no. 33, Aug. 13, 1937, pp. 1114-1118. Simultaneous tests of Hatch and Greenburg-Smith impingers show both give same dust count within limits of personal error. Description and diagram of new type all-glass (Pyrex) impinger which is believed to have best features of both Hatch and Greenburg impingers. New dust counter is easy to sterilize and has new features making it simpler to use.

• Chart for Determining Heat Absorbing Capacity of Coils from Air Measurements, by J. R. Onderdonk. *Refrigerating Engineering*, vol. 34, no. 5, Nov. 1937, p. 304. Chart is designed to determine directly the cooling effect of a coil, such as the cooling coil of an air conditioning installation, from measurements of the volume and the dry-bulb and wet-bulb temperatures of the air passing through the coil. It may be used to measure the heat load of an evaporative condenser.

• Air Requirement for Combustion, by James Gibbons. *Industrial Power*, vol. 33, no. 4, Oct. 1937, p. 66. Method of estimating amount of air handled by a furnace, burning gas, oil or coal. Amount of air required for combustion of fuel and weight of flue gas produced.

• More Comfort by Air Conditioning, by Benjamin F. Betts. *American Building Association News*, Cincinnati, Ohio, May 1937. Technical discussion with valuable details. Method of cooling air by refrigerants or cold water. Partial cooling by fans or with cool night air.

• Chicago Adopts Set of Minimum Design Requirements for Comfort Air Conditioning Installations, by John Howatt, chairman of Committee. *Domestic Engineering*, vol. 150, no. 4, Oct. 1937, pp. 87-88 and 176-177. Air conditioning standards for comfort in Chicago. Copy of minimum requirements for air conditioning.

• Light in the Schoolroom, by Dr. Edward Jackson. *Journal of American Medical Association*, vol. 109, no. 11, Sept. 11, 1937, pp. 841-2. A plea for better lighting in the schoolroom. Some data on lighting in various locations in room lighted by windows. Adequate light in schoolroom depends upon knowledge of what is good lighting by the teacher, the parents and pupils and the knowledge of the value of good lighting by the school authorities, school architects and school financiers.

• Pipe Corrosion and Coatings. Pipe Corrosion Protection, by Erick Larson. *American Gas Journal*, vol. 147, no. 3, Sept. 1937, pp. 21-24. Description of pipe coatings used to prevent corrosion and pipe wrapping used to protect coating from physical injuries. Methods of handling insulated pipe.

• Air Conditioning Theory and Practice, by Arthur M. Branch and Rolf Toensfeldt. *Buildings and Building Management*, Mar. 1937. The paper is technical with many details. Discussion of human heat regulating system by perspiration, beginning at 63 F, with maximum effect at 85 F. Air conditioning aims to hold temperatures between these temperature limits and to regulate moisture to produce most comfortable condition.

• Performance of Underfeed Stokers, by Julius Brodsky. *Power Plant Engineering*, vol. XLI, no. 10, Oct. 1937, pp. 618-9. The value of performance curves as a guide to selection of coal and of draft equipment. Characteristic performance curves discussed.

• Nature of Silicosis. *Concrete (Cement Mill Edition)*, vol. 45, 1937, pp. 171-172. Reports of the first National Silicosis Conference, 1936, and the second National Silicosis Conference, 1937, are given.

• Steam Traps and Their Characteristics, by T. Napier Adlam. *Heating and Ventilating*, vol. 34, nos. 7, 8, 9, and 10. Contained in four issues as follows: 1. What traps do and how thermostatic traps work. July 1937, pp. 44-47. 2. Float and bucket traps. Aug. 1937, pp. 51-54. Diagrams of trap construction. 3. Expansion, orifice, impulse and siphon traps. Sept. 1937, pp. 69-71. 4. Calculation for steam trap capacities. Oct. 1937, pp. 51-53. Discussion of operating principles and uses of many kinds of steam traps. Examples showing estimation of condensate which traps must handle in certain steam using devices.

• Beihefte zum Gesundheits Ingenieur, Reihe 1, Heft 36. Die heiztechnischen Neuanlagen des Stadtischen Krankenhauses Bad Cannstatt, by H. Wolfer. Published by R. Oldenburg, Munich and Berlin, 1937. 24 pages. Price 4.80 rm. Description of a power plant of a large German hospital and results of an operating test. The tests give in detail the consumption of heat, water, gas and electric current in the hospital.

New York Prepares for January Meeting

Hotel Biltmore

January 24-28, 1938

Midtown at night

DURING the week of January 24, New York will attract the leaders in the heating, ventilating, air conditioning and refrigeration fields, as visitors will come from every city in the United States, Canada and many foreign countries to attend the 44th Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, at the Hotel Biltmore, and the winter meetings of the *American Society of Refrigerating Engineers,* and the *National Warm Air Heating and Air Conditioning Association,* at the Hotel Roosevelt, as well as the 5th International Heating and Ventilating Exposition in Grand Central Palace.

According to an announcement by A. C. Buensod, Chairman of the Committee on Arrangements, for the A. S. H. V. E., both the technical and entertainment programs have been completed so that everyone is assured of an enjoyable time. An active committee of the New York Chapter has been developing a program of entertainment for visiting members and friends so that after each technical session there will be some interesting diversion.

The exposition at Grand Central Palace will open at 2:00 p. m. on Monday, January 24, and remain open thereafter daily from 12 noon to 10:30 p. m.

The first social event will be the president's reception and get-acquainted dinner in the Hotel Biltmore on Monday evening. On Tuesday it is planned to have members of the three organizations participate in a joint party at the International Casino and enjoy a midnight supper and show.

One afternoon will be devoted to inspection of the new Lincoln Vehicular Tunnel and other places of interest.

The annual banquet is scheduled for Thursday evening, January 27, and while the men are attending technical sessions the ladies will be entertained for luncheon, at the theatre, at a bridge party and a shopping tour.

An added entertainment feature following the meeting will be a cruise party to Bermuda sailing January 29 and returning February 4.

At the technical sessions a variety of papers on all phases of heating, ventilating and air conditioning will be presented and discussed. The topics will include application of district heating to steam jet refrigeration, recent results of warm air research studies of air distribution, physiological reactions to air changes, bacteria and air conditioning, control of air conditioning equipment, office building air conditioning requirements, new lighting developments, and the effect of air conditioning, heat transmission through windows, and condensation in walls. Engineers and scientists of national reputation will present these papers and read the discussions.

A conference of delegates representing the Society's 25 local chapters will be held January 24 with Pres. D. S. Boyden presiding and the discussions will be devoted to the problems of chapter administration.

The Council will hold a meeting January 24 in advance of the technical sessions and, on January 28, the new Council will hold its organization meeting.

There will be joint sessions with the *National Warm Air Heating and Air Conditioning Association* and the *American Society of Refrigerating Engineers.* The week of January 24 will be a busy time for those who attend the meetings and exposition.

COMMITTEE ON ARRANGEMENTS

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Alfred Engle, *Vice-Chairman*

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J. G. Eadie
C. S. Koehler
T. W. Reynolds
G. W. Martin

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Louis Hament
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K. L. Mytinger

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Mr. and Mrs. D. J. Purinton
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W. A. Sherbrooke
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Hotel Biltmore

Program

44th Annual Meeting

Hotel Biltmore, New York

Monday—January 24

9:30 a. m.—Registration.

10:00 a. m.—Conference of Chapter Delegates.

12:30 p. m.—Council Meeting.

2:00 p. m.—Opening of Heating and Ventilating Exposition.

6:30 p. m.—Get-acquainted Dinner (Bowman Room).
President's Reception.

Tuesday—January 25

9:00 a. m.—Registration.

9:30 a. m.—First Session.
Greetings—W. E. Heibel, President, New York Chapter.
Response—President D. S. Boyden.
Reports of Committees.
Technical Paper—
Application and Economy of Steam Jet Refrigeration to Air Conditioning, by A. R. Mumford and A. A. Markson.
Cooling Tower Equipment and Its Relation to Water Conservation, by S. I. Rottmayer.
Report of Tellers of Election.

12:00 noon—Heating and Ventilating Exposition.

2:00 p. m.—Joint Session with *National Warm Air Heating and Air Conditioning Association.*
Technical Paper—
Air Distribution from Side Wall Outlets, by D. W. Nelson and D. J. Stewart.
Condensation within Walls, by F. B. Rowley, A. B. Algren and C. E. Lund.

10:00 p. m.—International Casino Party.

Wednesday—January 26

9:30 a. m.—Technical Papers—
Studies on Bacterial Control in Air Conditioning, by T. S. Carswell, J. D. Fleming and H. K. Nason.
Physiologic Response of Man to Environmental Temperature, by Dr. F. K. Hick, Dr. R. W. Keeton and Nathaniel Glickman.
Control of Body Heat Loss Through Radiant Means, by Dr. C. A. Mills and Dr. Cordelia Ogle.
Summer Cooling Requirements of 275 Workers in an Air Conditioned Office, by A. B. Newton, F. C. Houghten, Carl Gutberlet and R. W. Qualley.

12:00 noon—Heating and Ventilating Exposition.

2:00 p. m.—Joint Session with *American Society of Refrigerating Engineers.*
Technical Papers—
Control of Air Conditioning in Large, Medium, and Small Buildings, by W. E. Zieber and S. F. Nichol.
Physiological Reactions and Sensations of Comfort under Various Atmospheric Conditions, by C.-E. A. Winslow, L. P. Herrington and A. P. Gagge.
Performance Tests of Asbestos Insulating Air Duct, by R. H. Heilman and R. A. MacArthur.

6:30 p m—Past Presidents' Dinner.

Thursday—January 27

9:30 a. m.—Technical Papers—
Heating Effects of Artificial Lighting on Air Conditioning, by Walter Sturrock.
Comparative Analysis of Office Building Air Conditioning Systems, by J. R. Hertzler.
Characteristics of an Electrostatic Precipitator, by H. W. Tenney.
Heating and Ventilating the Lincoln Vehicular Tunnel, by C. W. Murdock.

12:00 noon—Heating and Ventilating Exposition.

2:00 p. m.—Inspection Trip Lincoln Vehicular Tunnel.

7:00 p. m.—Annual Banquet.

Friday—January 28

9:30 a. m.—Technical Papers—
Drop in Skin Temperature and Sense of Coolness with Various Air Conditions, by F. C. Houghten.
Study of Methods of Control and Types of Registers as Affecting Temperature Variations in the Research Residence, by A. P. Kratz and S. Konzo.
Heat Transfer through Single and Double Glazed Steel Sash, by M. L. Carr, R. A. Miller, A. C. Byers and Leighton Orr.

12:00 noon—Council Meeting.

12:00 noon—Heating and Ventilating Exposition.

At Hamilton Harbor, Bermuda

NOMINATIONS FOR 1938

The Nominating Committee appointed to select candidates for Officers of the Society for the coming year, 1938, submits the following list of nominees:

For President:

E. H. GURNEY, Toronto, Ont., Can.

For First Vice-President:

J. F. MCINTIRE, Detroit, Mich.

For Second Vice-President:

F. E. GIESECKE, College Station, Tex.

For Treasurer:

A. J. OFFNER, New York, N. Y.

For Members of the Council:

Three-Year Term

N. D. ADAMS, Rochester, Minn.
A. P. KRATZ, Urbana, Ill.
J. H. WALKER, Detroit, Mich.
G. L. WIGGS, Montreal, Que., Can.

Respectfully submitted,

NOMINATING COMMITTEE,

N. D. ADAMS, *Chairman*
C. E. PRICE, *Secretary*

In accordance with the provisions of the Amended Constitution, as given, ballots containing the names of the above candidates will soon be sent to the membership for voting upon prior to the Annual Meeting in January.

Art. B-VIII—Section 10. The Nominating Committee shall consist of one (1) member eligible to vote designated by each Chapter, or his alternate also appointed by the Chapter. The Secretary of each Chapter shall certify to the Secretary of the Society on or before January first the names of the member and alternate selected.

The Committee shall meet at the Annual Meeting of the Society at the call of the Secretary of the Society and shall effect its own organization and elect its own Chairman. At the Semi-Annual Meeting of the Society, if possible, the Nominating Committee shall select the nominees for the ensuing year for the offices of President, First Vice-President, Second Vice-President, Treasurer, and four (4) members of the Council. In any event the names of the nominees shall be certified to the Secretary of the Society before September twentieth, with the written consent of each nominee to fill the office for which he has been selected and their names with the offices to which they have been nominated shall be published in the October issue of the JOURNAL.

Art. B-IX—Section 2. The Secretary shall prepare ballots with the names of all candidates and forward them to the members, eligible to vote, at least thirty (30) days before the date of the Annual Meeting.

Nominations for Members of Committee on Research

Although committees of the Society are usually appointed, in view of the great importance of the Committee on Research and the financial responsibility it would be called upon to assume, it has been made more representative of the entire membership of the Society by a process of *election*. The election is governed by the By-Laws for the election of officers, with the single exception that Members of the Committee on Research are nominated by the Council instead of by a Nominating Committee.

In accordance with the Regulations for the Government of the Research Laboratory, adopted at the January, 1919, Meeting, and amended January, 1933, the Council announces the nomination of the following members of the Committee for election to succeed those members whose present terms expire January, 1938:

Three-Year Term

M. K. FAHNESTOCK, Urbana, Ill.
W. L. FLEISHER, New York, N. Y.
R. J. TENKONOHY, St. Louis, Mo.
T. H. URDAHL, Washington, D. C.
B. M. WOODS, Berkeley, Calif.

The regulations governing the nomination and election of members of the Committee on Research are as follows:

ARTICLE II—ORGANIZATION

Section 1. *Committee on Research*—There shall be a standing committee known as the Committee on Research, consisting of fifteen (15) members each serving for three (3) years and five (5) retiring each year. The outgoing Chairman if serving in that capacity during the last year of his three (3) year term on the Committee shall without election become an additional member of the Committee on Research for one (1) year.

(*a*) The Council shall nominate previous to July first of each year five (5) members to fill the vacancies of those retiring at the next Annual Meeting.

(*b*) The nominations made by the Council shall be published in the October issue of the Society's JOURNAL.

(*c*) Any ten (10) members of the Society eligible to vote may present to the Secretary over their signatures, the name of one (1) or more additional nominees for the Committee on Research, provided such name or names are presented at least sixty (60) days prior to the next Annual Meeting, and such additional nominations shall be placed on the ballot opposite the nominations made by the Council.

(*d*) The election shall otherwise conform to the regulations provided for the election of officers of the Society in the Constitution, By-laws and Rules.

(*e*) Vacancies may be filled by the Council, such persons chosen by the Council to serve until a successor is elected at the next Annual Meeting.

NEWS OF LOCAL CHAPTERS

OFFICERS OF LOCAL CHAPTERS—1937

ATLANTA: *Organized,* 1937. *Headquarters,* Atlanta, Ga. *Meets,* First Tuesday. *President,* E. W. KLEIN, 152 Nassau St., N. W. *Secretary,* C. T. BAKER, 713 Glenn St., S. W.

CINCINNATI: *Organized,* 1932. *Headquarters,* Cincinnati, O. *Meets,* Second Tuesday in Month. *President,* I. B. HELBURN, 610 Chamber of Commerce Bldg. *Secretary,* H. E. SPROULL, 1005 American Bldg.

GOLDEN GATE: *Organized,* 1937. *Headquarters,* San Francisco, Calif. *Meets,* First Tuesday. *President,* B. M. WOODS, Univ. of Calif., Berkeley, Calif. *Secretary,* G. J. CUMMINGS, 113 Tenth St., Oakland, Calif.

ILLINOIS: *Organized* 1906. *Headquarters,* Chicago, Ill. *Meets,* Second Monday. *President,* S. I. ROTTMAYER, 407 S. Dearborn St. *Secretary,* C. E. PRICE, 6 N. Michigan Ave.

IOWA-NEBRASKA: *Organized,* 1937. *Headquarters,* Omaha, Neb. *President,* M. J. STEVENSON, 1643 South 20th St., Lincoln, Neb. *Secretary,* W. R. WHITE, 4339 Larimore Ave., Omaha, Neb.

KANSAS CITY: *Organized,* 1917. *Headquarters,* Kansas City, Mo. *Meets,* Second Monday in Month. *President,* A. H. SLUSS, 827 Mississippi Ave., Lawrence, Kan. *Secretary,* GUSTAV NOTTBERG, 914 Campbell St.

MANITOBA: *Organized,* 1935. *Headquarters,* Winnipeg, Man. *Meets,* Fourth Thursday. *President,* D. F. MICHIE, 492 Wardlaw Ave. *Secretary,* E. J. ARGUE, Ste. 23, Estelle Apts.

MASSACHUSETTS: *Organized,* 1912. *Headquarters,* Boston, Mass. *Meets,* Third Tuesday in Month. *President,* JAMES HOLT, Massachusetts Institute of Technology, Cambridge, Mass. *Secretary,* H. C. MOORE, 69 Massachusetts Ave., Cambridge, Mass.

MICHIGAN: *Organized,* 1916. *Headquarters,* Detroit, Mich. *Meets,* First Monday after the 10th of the Month. *President,* F. J. FEELY, 950 Trombley Rd., Grosse Pointe Pk. *Secretary,* G. H. TUTTLE, 2000 Second Ave.

WESTERN MICHIGAN: *Organized,* 1931. *Headquarters,* Grand Rapids, Mich. *Meets,* Second Monday in Month. *President,* W. W. BRADFIELD, 901 Michigan Trust Bldg. *Secretary,* S. W. TODD, JR., 309 Paris, S. E.

MINNESOTA: *Organized,* 1918. *Headquarters,* Minneapolis, Minn. *Meets,* Second Monday in Month. *President,* R. E. BACKSTROM, Room 1981, First Natl. Bank Bldg., St. Paul, Minn. *Secretary,* F. C. WINTERER, 836 Juno St., St. Paul, Minn.

MONTREAL. *Organized,* 1936. *Headquarters,* Montreal, Que. *Meets,* Third Monday. *President,* G. L. WIGGS, University Tower. *Secretary,* C. W. JOHNSON, 630 Dorchester St., W.

NEW YORK: *Organized,* 1911. *Headquarters,* New York, N. Y. *Meets,* Third Monday in Month. *President,* W. E. HEIBEL, 11 West 42nd St. *Secretary,* T. W. REYNOLDS, 100 Pinecrest Dr., Hastings-on-Hudson, N. Y.

WESTERN NEW YORK: *Organized,* 1919. *Headquarters,* Buffalo, N. Y. *Meets,* Second Monday in Month. *President,* B. C. CANDEE, 19 Tremont Ave., Kenmore, N. Y. *Secretary,* W. R. HEATH, 119 Wingate Ave.

NORTHERN OHIO: *Organized,* 1916. *Headquarters,* Cleveland, O. *Meets,* Second Thursday in Month. *President,* PHILIP COHEN, 401 East Ohio Gas Bldg. *Secretary,* C. A. MCKEEMAN, Case School of Applied Science.

OKLAHOMA: *Organized,* 1935. *Headquarters,* Oklahoma City, Okla. *Meets,* Second Monday. *President,* E. F. DAWSON, University of Oklahoma, Norman, Okla. *Secretary,* E. W. GRAY, Box 1498, Oklahoma City, Okla.

ONTARIO: *Organized,* 1922. *Headquarters,* Toronto, Ont. *Meets,* First Monday in Month. *President,* G. A. PLAYFAIR, 113 Simcoe St. *Secretary,* H. R. ROTH, 57 Bloor St. W.

PACIFIC NORTHWEST: *Organized,* 1928. *Headquarters,* Seattle, Wash. *Meets,* Second Tuesday in Month. *President,* W. W. COX, 326 Columbia St. *Secretary,* M. N. MUSGRAVE, 314-9th Ave., N.

PHILADELPHIA: *Organized,* 1916. *Headquarters,* Philadelphia, Pa. *Meets,* Second Thursday in Month. *President,* L. P. HYNES, 240 Cherry St. *Secretary,* C. B. EASTMAN, 530 Brookview Lane, Brookline, Upper Darby, Pa.

PITTSBURGH: *Organized,* 1919. *Headquarters,* Pittsburgh, Pa. *Meets,* Second Monday in Month. *President,* M. L. CARR, P. O. Box 1646. *Secretary,* T. F. ROCKWELL, Carnegie Inst. Tech.

ST. LOUIS: *Organized,* 1918. *Headquarters,* St. Louis, Mo. *Meets,* First Tuesday in Month. *President,* G. W. F. MYERS, 3947 W. Pine Blvd. *Secretary,* D. J. FAGIN, 1344 Woodruff Ave.

SOUTHERN CALIFORNIA: *Organized,* 1930. *Headquarters,* Los Angeles, Calif. *Meets,* Second Tuesday in Month. *President,* E. H. KENDALL, 1978 S. Los Angeles St. *Secretary,* J. F. PARK, 1234 South Grand.

TEXAS: *Organized,* 1936. *Headquarters,* College Station, Texas. *President,* R. F. TAYLOR, 909 Banker's Mortgage Bldg., Houston, Tex. *Secretary,* W. H. BADGETT, Texas Engrg. Experiment Station, College Station, Tex.

WASHINGTON, D. C.: *Organized,* 1935. *Headquarters,* Washington, D. C. *Meets,* Second Wednesday in Month. *President,* L. OURUSOFF, 411 Tenth St., N. W. *Secretary,* L. F. NORDINE, Room 203, 734 Jackson Pl., N. W.

WISCONSIN: *Organized,* 1922. *Headquarters,* Milwaukee, Wis. *Meets,* Third Monday in Month. *President,* J. H. VOLK, 1906 W. St. Paul Ave. *Secretary,* H. C. FRENTZEL, 3000 W. Montana St.

R. E. Hattis and L. A. Harding Address Western New York Chapter

November 8, 1937. Western New York Chapter held a meeting at the University Club with 29 present for dinner and 42 members and guests attending the session following.

The minutes of the previous meeting were read and approved, and J. J. Landers announced that the annual Christmas party would be held at the University Club in December. Joseph Davis said that plans for this party included a handicap bowling tournament.

An announcement was made of the reinstatement of initiation fees for the A. S. H. V. E. effective January 1, 1938, and Chapter members were urged to tell all prospective members to file their applications promptly.

A resolution by Roswell Farnham relating to the membership of the Board of Governors was read and approved for submission to the Board.

Pres. B. C. Candee introduced the speaker of the evening, R. E. Hattis, consulting engineer, Chicago. Mr. Hattis described in detail, with the help of lantern slides, an air conditioning system installed in a windowless building. The members present found this talk very interesting and had many questions for Mr. Hattis. It is felt that the Chapter enjoyed one of its most instructive and interesting meetings.

October 11, 1937. Western New York Chapter held its October meeting at the University Club when 40 members were present for dinner and approximately 55 attended the meeting.

The Minutes of the Chapter's Annual Meeting held in May were read and approved, and C. A. Gifford presented a detailed treasurer's report. J. J. Landers, chairman of Program Committee, outlined the tentative program of meetings for the ensuing year.

Pres. B. C. Candee introduced L. A. Harding as the speaker of the evening. His talk on The Sun was illustrated with lantern slides and many pieces of unique apparatus. In his usual interesting manner Mr. Harding told many things about the Solar System and traced the history of power development from the sun's rays from the first recorded experiments down to the present day.

Secy. W. R. Heath reports that the meeting adjourned at 10:30 p. m.

E. W. Klein
President

T. T. Tucker
Vice-President

C. T. Baker
Secretary

Atlanta Chapter Holds Round Table Discussion

November 2, 1937. Pres. E. W. Klein presided at a meeting of Atlanta Chapter held at the Atlanta Biltmore Hotel. Minutes of the previous regular meeting and of the special Charter presentation meeting on October 12 were read and approved.

Following a discussion of routine matter, including the appointment of a program committee to arrange programs for next year, and a discussion of the question of the presentation of papers by members of the local chapter, a general round-table discussion was held covering subjects of general interest. A number of interesting suggestions were brought out in these discussions.

Secy. C. T. Baker read several communications which had been received since the previous meetings. Among them was an announcement from the national secretary concerning the annual meeting of 1939, advising that this meeting would be held in Pittsburgh in January, 1939, and expressing the hope that Atlanta Chapter would renew its invitation for some future meeting of the Society beyond this date. The Secretary was instructed to follow this through to conclusion.

Secretary Baker announced that effective January 1, 1938, initiation fees for new membership would be restored in the A. S. H. V. E.

Air Pollution Interests Massachusetts Chapter Members

October 26, 1937. Thirty-four members of Massachusetts Chapter were guests of the Harvard School of Public Health when Prof. Philip Drinker spoke on work that was being done, and gave an enlightening talk on Atmospheric Pollution in Air Conditioning.

This was followed by an address by Manfred Bowditch, head of the Massachusetts Department of Occupational Hygiene, who told of the work which his department was attempting to carry out and the conditions which were frequently met.

An interesting discussion followed the talks and both speakers answered a number of questions, after which refreshments were served, according to the report of Secy. H. C. Moore.

Production and Use of Steel Seen by St. Louis Chapter Members

September 14, 1937. Pres. G. W. F. Myers called the St. Louis members to order at a meeting held at Garavelli's Restaurant with 20 members and 14 guests present.

President Myers reviewed the meeting of the Joint Council of The Associated Engineering Societies of St. Louis when a letter was read suggesting that the Governor be urged to appoint an engineer to fill one of the vacancies on the Board of Curators of the University of Missouri.

Secy. D. J. Fagin read a letter from the president of Southern California Chapter of the Society at Los Angeles, inviting local members to attend their meetings when visiting Los Angeles.

A letter was also read from R. C. Bolsinger, chairman of the A. S. H. V. E. Membership Committee urging each member to secure at least one additional member during the coming year.

It was recorded that the following members had been elected to membership in the Society: E. F. Weber, Jr., W. A. Siegel, C. V. Allen, R. R. Irwin, A. G. Matoúsek, J. S. Warren, Jr., B. L. Evans.

Treas. C. E. Hartwein reported a balance as of September 14, 1937, of $426.45.

Reports of standing committees were called for and E. E. Carlson spoke for the Program Committee, C. F. Boester, Jr., reported for the Membership Committee.

President Myers introduced M. R. Bass, director of the Ranken School, who invited all St. Louis Chapter members to use facilities of their cafeteria, etc., for meetings when they so desired.

A number of guests were introduced by President Myers, including Nick Veeder, Richard Orthwein, and A. C. Stoever of the Granite City Steel Company, Messrs. Sandes and Shields of the Controlled Air Corporation, Messrs. Giles and Hays of the Owens Illinois Glass Company, Mr. Wilkening of the Sodemann Heat and Power Company, and Mr. Harbold of the Frick Company.

R. J. Tenkonohy was congratulated on his nomination to membership to the Society's Research Committee.

Mr. Carlson introduced F. G. White of the Granite City Steel Company who presented a sound picture entitled A Story in Steel. At the conclusion of the picture Mr. White answered a number of questions. This program proved very interesting, particularly in regard to the application of steel sheets and their adaptability to air conditioning work; as well as treatment of the sheets to prevent scaling of paint from air conditioning ducts.

President Myers closed the meeting after a rising vote of thanks to Mr. White.

Future Trends in Heating and Air Conditioning at Minnesota Chapter

November 8, 1937. The regular meeting of the Minnesota Chapter was held in the Minnesota Union, University of Minnesota, and approximately 65 members and guests attended. Dinner was served at 6:30 p. m., after which Pres. R. E. Backstrom called the meeting to order. After introduction of new members, guests and prospective members, minutes of the previous meeting were read and approved.

Announcement was made that effective January 1, 1938, initiation fees for new members will be restored.

The advisability of having an annual party was discussed, after

which it was voted that the 1937-1938 party be held and that the Entertainment Committee proceed with necessary arrangements.

President Backstrom announced N. D. Adams' nomination to the Council.

President Backstrom then turned the meeting over to G. C. Morgan to introduce the speaker of the evening, E. L. Hogan, of Detroit, research engineer, of American Blower Corp. Mr. Hogan gave an illustrated address on History of Methods and Equipment and Future Trends in Air Conditioning. Mr. Hogan explained with illustrations the various types of equipment used in both commercial and residential types of air conditioning. After Mr. Hogan's address there was a question and discussion period which indicated considerable interest in the subject of Mr. Hogan's talk.

There being no further business, motion to adjourn was carried.

October 11, 1937. Approximately 70 members and guests of Minnesota Chapter were conducted on an inspection trip to Minneapolis-Honeywell Regulator Co.'s air conditioning plant and research bungalow at 6:00 p. m.

At 7:00 p. m. members and guests assembled in the cafeteria for dinner, after which the meeting was called to order by Pres. R. E. Backstrom. When the minutes of the September meeting had been read and approved President Backstrom turned the meeting over to F. W. Legler, who introduced the speaker, C. W. Nessell.

The subject of Mr. Nessell's address was: The Trend in Warm Air Residential Heating. Mr. Nessell explained the development of warm air heating from its infancy to the present time and what he forecast for the future trend in this phase of heating.

President Backstrom urged early payment of local chapter dues and a drive for new Society members.

There being no further business, the meeting was adjourned, according to the report of Secy. F. C. Winterer.

Automatic Residence Heating Subject of Pittsburgh Chapter

November 8, 1937. Pres. M. L. Carr called the meeting of Pittsburgh Chapter to order in the private dining room of Stouffer's Restaurant. There were 57 members and guests present when the minutes of the October meeting were read and approved.

The Nominating Committee presented the following candidates for election at the December meeting:

President—J. F. S. Collins, Jr.
Vice-President—R. A. Miller.
Secretary—T. F. Rockwell.
Treasurer—L. S. Maehling.
Board of Governors—M. L. Carr, E. H. Riesmeyer, Jr., E. C. Smyers.

R. J. J. Tennant reported for the Social Committee and briefly outlined the plan for the annual meeting of the Chapter.

Mr. Collins, chairman of the Program Committee, announced that Mr. Purcell, Allegheny County Steam Heating Co., would speak at the January meeting on District Heating.

Prof. C. M. Humphreys, member of the A.S.H.V.E. Council, stated that the invitation of the Pittsburgh Chapter for the 1939 Annual Meeting of the A.S.H.V.E. had been accepted.

President Carr introduced R. A. Sherman, fuel engineer of Battelle Memorial Institute, Columbus, as the speaker of the evening. Mr. Sherman's subject was Automatic Residence Heating with Bituminous Coal and he described laboratory methods used to study the action of coal in domestic sized stokers. He next discussed the stoker as a machine and then as a combustion device. Mr. Sherman illustrated his paper with slides, among which were some actual photographs of fire which showed the coke formations of various coals.

Secretary Rockwell reports that the members and guests were greatly interested in Mr. Sherman's talk and a lengthy discussion from the floor followed the conclusion of his paper.

Western Michigan Chapter Members Discuss Heating

November 8, 1937. Seventy members and guests were present at the meeting of Western Michigan Chapter at the Mertens Hotel, Grand Rapids. Chapter members took part in a discussion on various phases of heating. The latest developments in hot water heating were presented by V. C. Deane, heating engineer, Standard Sanitary Mfg. Co.; for steam, Stanley Worthing, consulting engineer, led the discussion; and for air, Prof. L. G. Miller, Michigan State College, was in charge.

Each speaker developed his presentation from a small house plan, loaned for the occasion by Warren Rindge, architect. Heat losses were figured and costs were analyzed. A number of questions were asked at the conclusion of each presentation and answered by the speakers.

This type of meeting met with considerable response from the members, according to the report of Secy. S. W. Todd, Jr., and it was decided to have a similar discussion of various fuel mediums in February.

Meetings of the Chapter will be held in Grand Rapids throughout the year, except for the December meeting at Kalamazoo and the March meeting at Lansing. The increased interest in membership and attendance is very gratifying to the Chapter, seven new members being added at the November meeting.

The Board of Governors selected Pres. W. W. Bradfield to represent the Chapter at the Society's Annual Meeting in New York.

Prof. Hoffman Tells Michigan Chapter About Warm Air Heating

November 8, 1937. Approximately 250 members and guests of Michigan Chapter were present at the meeting held at the Wardell Hotel at 6:30 p. m. After dinner Pres. F. J. Feely asked for roll call and reports of the Secretary, the Membership Committee and the Treasurer.

Two proposed amendments to the by-laws of the Michigan Chapter Constitution were read by Secy. G. H. Tuttle, relating to Chapter dues and the duties of the Treasurer. The amendments were adopted as read by a unanimous vote.

President Feely then introduced F. R. Bishop who in turn presented the speaker of the evening, Prof. J. D. Hoffman, Purdue University.

Professor Hoffman spoke on the subject of Forced Air Heating and summarized the progress of warm air heating industry from first gravity systems to the present forced-air systems. He pointed out some common faults of residence constructions which affect the heating efficiency of a plant such as faulty chimneys, poor windows, lack of insulation and inferior workmanship. He urged closer cooperation between the heating engineer and the architect engaged in residence construction.

A lively discussion followed the talk and the meeting was adjourned at 10 p. m. with everyone giving a rising vote of thanks to Professor Hoffman.

Crane Co. Appoints Director of Engineering and Research Division

Announcement has been made by C. B. Nolte, president, Crane Co., Chicago, Ill., of the formation of a division of engineering and research with L. W. Wallace as director, effective December 1. Mr. Wallace will direct the originating of new lines of products, the development of inventions and patents, and the maintenance of existing Crane products. Mr. Wallace has been director of engineering research for the *Association of American Railroads* for the last three years and formerly was secretary of the *American Engineering Council*.

Greenleaf Opens Consulting Office in Cleveland

Announcement has been made by Robert P. Greenleaf of the establishment of an office for engineering consultation and design in air conditioning at 2804 East 132nd St., Cleveland, Ohio. With

R. P. Greenleaf

30 years engineering experience in building construction, heating, ventilating and air conditioning, Mr. Greenleaf outlines his plan of specializing in the consulting field and devoting particular attention to those who require advice on air conditioning problems. Mr. Greenleaf is a graduate of Case School of Applied Science with degrees of B.S. and M.E. and is a registered professional engineer in Ohio, licensed to practice mechanical and structural engineering.

Armco Laboratory Opened

More than 200 scientists from all parts of the country were guests of The American Rolling Mill Company at the dedication of Armco's colorful new research laboratories in Middletown, Ohio, on November 5.

"Research is what keeps industry healthily dissatisfied with itself," was the keynote of the dedicatory address by C. F. Kettering, vice-president in charge of research of General Motors Corp., at the banquet which concluded the days' activities.

G. M. Verity, chairman of the board of Armco, told his audience that, "from the courage and brains of men who have refused to accept today's products as representative of perfection has come the impetus that has given the highest standard of living known in the world, and which has provided profitable investment for savings of the nation, and work and more abundant opportunities for millions of men."

The president of Armco, C. R. Hook, declared, "the real goal of industry is to find new products for old and new uses, so that as industry itself grows, more people will have the jobs and the money to buy these new conveniences." Mr. Hook expressed his belief that research is the key, industry the force that can turn the lock to achieve that goal.

Dr. Anson Hayes, director of research for Armco, was toastmaster.

Armco's new research laboratories

During the afternoon, guests inspected the new laboratories and the foundries, strip mills and other manufacturing facilities.

Proctor Appointed by G. E.

J. A. Proctor has been appointed assistant manager of the air conditioning department of General Electric Co., it has been announced by J. J. Donovan, manager. Mr. Proctor, who for the past three years has been assistant to C. E. Wilson, G-E vice president, will henceforth make his headquarters at Bloomfield, N. J.

New Offices and Factory

Announcement has been made by Economy Pumps, Inc., that general offices will be maintained at 2522 West Congress St., Chicago, Ill., and that manufacturing and engineering departments will be located at Hamilton, Ohio.

P. E. Fansler Dies Suddenly

The sudden death of P. E. Fansler on November 7, 1937, following a heart attack, came as a distinct shock to his many friends and associates. Recovering from an illness which he suffered three years ago, he had appeared to be in fairly good health, although for the past few years he spent most of the time on his farm at Catonsville near Baltimore, Md.

He was born at Grand Rapids in 1881 and attended the University of Chicago's Manual Training High School, graduating in 1897. He obtained his bachelor of science degree from Purdue University in 1901. The next two years he was assistant to the chief in the department of electricity at the St. Louis Exposition and studied for his professional degree at the same time. He made history by taking his examinations for the degree of electrical engineer by long distance telephone from St. Louis to Purdue University in 1903. Later he was associated with various

P. E. Fansler

engineering enterprises and internal combustion engine manufacturers.

As early as 1914 he had formed a commercial airline, flying passengers and freight between St. Petersburg and Tampa, Fla. After investigation, he was officially credited by the U. S. Government as having originated and operated the first commercial airline in the U. S. During the war he served as chief of the engine section of the Bureau of Aircraft Production in the eastern department, supervising Government contracts. He is well known for his editorial work, serving as special correspondent for *The Electrician* of London and *L'Electricien* of Paris, and as associate editor of *Heating and Ventilating Magazine*. He was the originator in 1925 of the degree-day system of heating load calculations, and is the author of House Heating with Oil Fuel, still used as an authoritative reference by engineers and architects. In 1926 when the Council of the American Society of Heating and Ventilating Engineers inaugurated a Department of Public Relations, Mr. Fansler was appointed secretary. In 1928 he formed Heating Journals, Inc. and at the time of his death was editor of *Air Conditioning and Oil Heat*.

Mr. Fansler was a member of the Purdue Alumni Clubs in

New York and Baltimore, of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, and a former member of the *American Institute of Electrical Engineers.*

The Officers and Council of the A.S.H.V.E. extend their sincere sympathy to his widow, Mrs. Mary Scott Fansler, and his family who survive.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 96 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge the members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by December 15, 1937, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
ALLAN, WILLIAM, Pres. & Treas., Allan Engrg. Co., Milwaukee, Wis.	J. H. Volk C. H. Randolph	H. C. Frentzel M. E. Erickson
BAKER, THOMAS, Engr., Suburban Air Cond. Corp., White Plains, N. Y.	A. A. Rose H. J. Rose	W. R. Fidelius M. E. Durkee
BALDWIN, K. F., JR., Engr., A. P. Woodson Co., Washington, D. C.	H. A. Welsh D. M. Robinson	Glegge Thomas H. R. Iverson
BARNES, A. F., Mech. Engr. & Owner, Texas Engrg. Co., Houston, Texas. (*Reinstatement*)	J. M. Frank A. G. Sutcliffe	E. K. Campbell E. K. Campbell, Jr.
BARTLEY, H. E., Director & Works Mgr., Matthews & Yates, Ltd., Swinton, Lancs., England	Walter Yates W. N. Haden	W. W. Nobbs G. N. Haden
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BOYAR, S. L., Estimating Supervisor, Sears Roebuck Co., Chicago, Ill.	B. F. McLouth R. H. Smith	Roy Lundquist (*Non-Member*) H. G. Rodda (*Non-Member*)
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BROWN, F. E., Sales Engr., Sidles Co., Airtemp Div., Des Moines, Iowa	M. J. Stevenson L. L. Daubert	B. F. Elbert G. S. Stiles
CONSTANCE, J. D., Draftsman, York Ice Mach. Corp., Brooklyn, N. Y.	V. Masterman (*Non-Member*) L. G. Bourgarde (*Non-Member*)	F. C. Fair (*Non-Member*) H. J. Masson (*Non-Member*)
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CRAWFORD, A. C., Power Engr., Potomac Elec. Power Co., Washington, D. C.	S. L. Gregg S. P. Eagleton	L. S. Ourusoff E. H. Lloyd
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WRIGHT, D. K., JR., Instructor, Case School of Applied Science, Cleveland, Ohio

REFERENCES

Proposers	*Seconders*
C. E. Bentley	L. H. Cochran
G. M. Simonson	G. J. Cummings
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C. C. Hellmers, Jr.	M. J. Stevenson
J. J. Landers	M. C. Beman
B. C. Candee	W. E. Voisinet
G. L. Tuve	H. E. Wetzell
Philip Cohen	F. A. Kitchen

Candidates Elected

In the past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

ARMISTEAD, W. C., Sales Engr., Nashville, Tenn.

BANNER, F. L. D., Br. Mgr., Minneapolis-Honeywell Reg. Co., Omaha, Nebr.

DAVIS, K. T., Engr., L. J. Mueller Furnace Co., Milwaukee, Wis.

DRISCOLL, M. G., Vice Pres., Bryant Equip. Co., Inc., Atlanta, Ga.

EARLE, F. E., Sales Engr., Stratford, Conn.

GILBERT, L. S., Owner, Gilbert Engrg. Co., Dallas, Texas.

HARBAUGH, J. W., Supt., Kupferle-Hicks Htg. Co., St. Louis, Mo.

LANDAU, MITCHEL, Mgr., Htg. & Air Cond. Dept., A. B. C. Oil Burner & Eng. Co., Philadelphia, Pa.

LEILICH, R. K., Western Mgr., The Marley Co., Los Angeles, Calif.

MARSHALL, A. W., Asst. Supt., Soho Public Baths, Pittsburgh, Pa.

NELSON, H. M., Pres., H. M. Nelson Co., Inc., Washington, D. C.

NORMAN, R. A., Prof. Mech. Engrg., Iowa State College, Ames, Iowa.

OONK, W. J., Dist. Mgr., B. F. Sturtevant Co., St. Louis, Mo.

ORR, LEIGHTON, Research Engr., Pittsburgh Plate Glass Co., Creighton, Pa.

OSTROM, Chief Engr., Schwerin Air Cond. Corp., Stromsnas Bruk, Sweden.

OUWENEEL, W. A., Air Cond. Engr., Standard Distributing Corp., Milwaukee, Wis.

PARKS, C. E., Dist. Mgr., Ilg Elec. Vtg. Co., Pittsburgh, Pa.

PETTIT, E. N., JR., Mech. Engr., Jos. W. Radotinsky, Kansas City, Kan.

POLLAK, RUDOLF, Chief Engr., Rockefeller Center, Inc., New York, N. Y.

ROSENBACH, R. F., Chief Engr., Sidles Co., Airtemp Div., Lincoln, Nebr.

SHIRLEY, W. B., Field Engr., Lennox Furnace Co., Charlotte, N. C.

TRAWICK, J. G., Dist. Repr., Minneapolis-Honeywell Reg. Co., Birmingham, Ala.

WINTHER, ANKER, Br. Air Cond. Engr., York Ice Mach. Corp., Cincinnati, Ohio. (*Advancement.*)

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LEHMAN, M. G., Owner & Sales Engr., M. G. Lehman, Lincoln, Nebr.

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LYCAN, L. K., Sales Mgr., Allison Insulation Co., Omaha, Nebr.

MARTYN, H. J., Pres., Martyn Bros., Inc., Dallas, Texas.

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Heating • Piping and Air Conditioning

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As will be noted, these abstracts are classified under general heads. In looking for information on a specific subject, it will be well to look through the abstracts under the most suitable heading, and also to look through those under the other headings. For example, some of the heating articles also contain information on air conditioning, and vice versa, *as the grouping has been made on the basis of the subject most prominently covered in the article.*

The index to the Journal Section *of the* American Society of Heating and Ventilating Engineers *is separate (see page* 787).

This index does not include Equipment Developments; Book Reviews; Booklets, Reports, and Papers; Recent Trade Literature; Conventions and Expositions; Schools and Study Courses; departments appearing regularly each month. The Editor's Page in each issue includes items of news, comments on current events, etc. In the January, 1937, *issue a complete directory section was published covering heating, piping and air conditioning equipment for industry and large buildings.*

Air Conditioning

Advantages of Air Conditioning Newspaper Plants
Vol. 9, *No.* 7. *July,* 1937. *p.* 112 (*back section*).
Summary of address on air conditioning newspaper plants; press room an important application; advantages through humidification; preventing ink mist; humidifying paper storage.

Advantages of an Air Conditioned Hospital
Vol. 9, *No.* 1. *January,* 1937. *p.* 24.
Report of meeting marking complete air conditioning of Corey Hill hospital, Brookline, Mass.; preliminary consideration given to air conditioning; importance of controlling atmospheric conditions; general importance of climate on health; rheumatic fever and heart diseases.

Air Conditioning for Food Plants
Vol. 9, *No.* 10. *October,* 1937. *p.* 658.
Abstract of paper by James Holt presented at food technology conference at Massachusetts Institute of Technology; requirements of food plants for air conditioning; advantages; use of air conditioning for meat in cooler storage.

Air Conditioning for Hospitals and in Normal Life
Vol. 9, *No.* 2. *February,* 1937. *p.* 96.
Review of papers presented by Philip Drinker and C. P. Yaglou at Harvard University symposium on the environment and its effects upon man; objectives and extent of air conditioning now applied to hospitals; conditions required; miscellaneous uses; application of air conditioning in normal life.

Air Conditioning Influences Building Design, by J. H. Walker
Vol. 9, *No.* 10. *October,* 1937. *p.* 599.
New service building being erected by the Detroit Edison Co., Detroit, Mich.; glass brick for exterior walls; heat and light transmission characteristics of glass brick; effect of air conditioning on cost of building; lighting coordinated with air conditioning; air conditioning windowless buildings; calculated refrgeration load; typical floor plan; diagram showing method of air circulation.

Air Conditioning in the Tropics Presents New Engineering Problems, by J. Neal Clemmer
Vol. 9, *No.* 9. *September,* 1937. *p.* 562.
General discussion of air conditioning requirements in the Philippines; comparison with practice in the United States; types of building construction and effect on air conditioning; acceptance of air conditioning.

Air Conditioning Load a Reason for New Gas Rate
Vol. 9, *No.* 4. *April,* 1937. *p.* 220.
New gas motor service rate established by Peoples Gas Light and Coke Co., Chicago, Ill.; reasons for establishing rate; terms.

Air Conditioning Society of San Francisco Adopts Standards for Air Conditioning
Vol. 9, *No.* 11. *November,* 1937. *p.* 122 (*back section*).
"California Standards of Air Conditioning for Human Comfort" adopted by Air Conditioning Society of San Francisco printed in full except for introductory section on definitions of terms.

Annual Air Conditioning Review
Vol. 9, *No.* 1. *January,* 1937. *p.* 31.
Number of air conditioning installations and connected horsepower for 1935, 1936, and totals as of December 1, 1936 for various cities; estimated increases predicted for 1937; number of air conditioned railroad cars and types of systems installed.

Applying Air Conditioning to an Existing Building, by M. Kennedy
Vol. 9, *No.* 10. *October,* 1937. *p.* 630.
Method of air conditioning the Brix building, Fresno, Calif.; design conditions; no moisture tonnage problem involved; how ducts were installed; advantages of horizontal corridor duct design over vertical riser method; each floor divided into two zones with volume regulation through dampers with gear controls; atmospheric cooling tower; "Freon" refrigeration equipment.

As Others See Us—an Englishman Studies American Air Conditioning, by John Pryke
Vol. 9, *No.* 9. *September,* 1937. *p.* 537.
Informal report of travels in U. S.; points of interest to air conditioning and heating engineers; photographs.

Blower Filter Unit Solves Press Room Problem, by F. S. Robinson
Vol. 9, *No.* 11. *November,* 1937. *p.* 665.
Installation at Benham and Munday printing plant, Indianapolis, Ind.; material from spray guns to prevent offset drifted throughout plant atmosphere; blower filter unit and duct work collects material; results.

Builds Air Conditioned Film Warehouse, by H. W. Sachs
Vol. 9, *No.* 11. *November,* 1937. *p.* 680.
Air conditioned warehouse of Agfa Ansco Co., Binghamton, N. Y.; temperature and humidity conditions; use of well water; brief description of air conditioning system; insulation and double glazing; glass block air conditioned office building.

Cold Weather Responsible for Printing Paper Troubles
Vol. 9, *No.* 1. *January,* 1937. *p.* 10.
Printing papers require certain handling precautions in cold weather; importance of temperature and humidity.

Condensing Water for Air Conditioning City Hall Is Put Back in Supply Main, by Joe Stocker
Vol. 9, *No.* 9. *September,* 1937. *p.* 548.
Air conditioning system for Oklahoma City city hall; condensing water returned to supply main; drawing of condensing water piping; pumps; temperature rise; safety provisions; charging for use of water; other articles of related interest.

Controls (Reference Sheet 6), by C. L. Ringquist
Vol. 9, *No.* 2. *February,* 1937. *p.* 111.
Four control layouts for cooling, ventilating and dehumidifying systems with diagrams and explanation of control cycles.

Controls (Reference Sheet 7), by C. L. Ringquist
Vol. 9, *No.* 3. *March,* 1937. *p.* 177.
Four control layouts for cooling, dehumidifying, ventilating and humidifying systems diagrammed; operating cycles explained.

Controls (Reference Sheet 8), by C. L. Ringquist
Vol. 9, *No.* 4. *April,* 1937. *p.* 245.
Three control arrangements for heating, ventilating, dehumidifying and cooling systems; operating cycles explained.

Controls (Reference Sheet 9), by C. L. Ringquist
Vol. 9, *No.* 5. *May,* 1937. *p.* 313.
Five control arrangements for heating, humidifying, ventilating, dehumidifying and cooling systems, and explanation of cycle of operation of each.

Controls (Reference Sheet 10), by C. L. Ringquist
Vol. 9, *No.* 6. *June,* 1937. *p.* 375.
Five arrangements of zone control systems with explanation of cycle for each.

Controls (Reference Sheet 11), by C. L. Ringquist
Vol. 9, *No.* 7. *July,* 1937. *p.* 435.
Three zone control arrangements with description of operating cycle of each.

Determining Presence of Chromates
Vol. 9, *No.* 12. *December,* 1937. *p.* 724.
Answer by C. M. Sterne to reader's question; procedure for determining presence of chromates in a solution with diphenyl carbazide; test very sensitive.

Don't Forget Air Conditioning Maintenance, by C. T. Baker
Vol. 9, *No.* 11. *November,* 1937. *p.* 674.
Importance of regular inspection and examination of air conditioning plants; example; loss of capacity due to infiltration; loss of capacity due to lack of insulation; dirty air filters; importance of proper location of outside air intake.

Effect of Air Conditioning Industry on Distribution
Vol. 9, *No.* 10. *October,* 1937. *p.* 658.
Review of paper presented by L. R. Boulware at Boston conference on distribution; use of air conditioning in tapping untouched supplies of raw materials; personnel relationships; buyer-seller relationships.

Effect of City Water Supply and Sewer Systems on Air Conditioning Reported
Vol. 9, *No.* 8. *August,* 1937. *p.* 480.
Description of report issued by Bureau of Foreign and Domestic Commerce; available water facilities of U. S. cities; table of temperature of water at main outlet and normal mean air temperature during summer months for cities of 100,000 population and over. (Also see p. 720, November, 1937, issue).

Electricity Used by Air Conditioning, by William P. Rock
Vol. 9, *No.* 4. *April,* 1937. *p.* 239.
Survey based on monthly meter readings for air conditioning installations in Chicago show how much electricity is used by air conditioning equipment; basis of survey; monthly kilowatthour and kilowatt readings for residential and commercial installations of various types; graphs; weather conditions.

Estimating the Potential Market for Commercial Air Conditioning, by Knight C. Porter and William P. Rock
Vol. 9, No. 1. January, 1937. *p.* 8.
Potential market for commercial air conditioning estimated for city of Chicago; installations plotted on map show their location in better economic areas; data on present electrical load, average load per store, per cent of total load on electric utility's lines, number of installations in each classification, and corresponding figures for market saturation for drug stores, beauty parlors, candy stores, restaurants, undertakers, and theaters; charts show connected horsepower for air conditioning and number of installations for prior to 1933, 1933, 1934, 1935, and 1936.

E. Vernon Hill's Personal Comments
Vol. 9, No. 5. May, 1937. *p.* 299.
Informal comments on increasing complexity of design of air conditioning systems because of the many types of equipment available; comments on the writing of air conditioning codes.

E. Vernon Hill's Personal Comments
Vol. 9, No. 6. June, 1937. *p.* 362.
Importance and duties of air conditioning operating engineers, service engineers and consulting engineers; definite classification of engineers and their respective duties would be of value.

E. Vernon Hill's Personal Comments
Vol. 9, No. 7. July, 1937. *p.* 414.
Air conditioning calculations simplified by specifying air quantities by weight instead of volume; elimination of use of relative humidity; comments on the word "ventilation".

E. Vernon Hill's Personal Comments
Vol. 9, No. 8. August, 1937. *p.* 496.
Remarks on how the human body controls its temperature; variation in temperature of the extremities; importance of medical research on the subject to air conditioning engineers.

E. Vernon Hill's Personal Comments
Vol. 9, No. 9. September, 1937. *p.* 564.
Discussion of vagueness of the words "heat" and "cold"; sensible heat; latent heat; superheat.

E. Vernon Hill's Personal Comments
Vol. 9, No. 10. October, 1937. *p.* 610.
No such thing as "saturated air"; mixtures of air and water vapor; relative weights; relative humidity.

E. Vernon Hill's Personal Comments
Vol. 9, No. 11. November, 1937. *p.* 666.
Difficulties in making capacity tests on air conditioning installations because of unsuitable outside conditions; method should be developed for making tests under changed conditions for fulfilling guarantees.

E. Vernon Hill's Personal Comments
Vol. 9, No. 12. December, 1937. *p.* 733.
Discussion of servicing air conditioning jobs and the functions and qualifications of the man engaged in servicing work; importance of proper servicing.

Five Air Conditioning Plants for World's Fair Building, by H. G. Schaefer
Vol. 9, No. 5. May, 1937. *p.* 310.
Brief description of World's Fair of 1939 in New York City; heating, ventilating and air conditioning equipment being installed.

Ford Motor Company Sets High Air Conditioning Standards, by J. J. Floreth
Vol. 9, No. 12. December, 1937. *p.* 729
Ford large user of comfort and process air conditioning; conditions air for workers' comfort; some Ford installations; establishment of Ford standards; temperature and humidity design conditions; materials; motors; workmanship and appearance; ducts, piping, grilles, etc.; procedure in bidding and awarding contracts; air condition assembly lines?

Frank Lloyd Wright Designs Air Conditioned Office Building for S. C. Johnson & Son
Vol. 9, No. 1. January, 1937. *p.* 185 (*back section*).
Brief description of general features of unusual office building for S. C. Johnson and Son, Inc., at Racine, Wis.; year round air conditioning provided for; panel heating.

Gas as a Source of Power for Air Conditioning, by B. A. Johnson
Vol. 9, No. 5. May, 1937. *p.* 298.
Use of gas engines as source of power for refrigeration for air conditioning; types of equipment available; comparing cost of gas engine power with electric power; chart.

Germicide in Spray Water Reduces Bacteria in Air
Vol. 9, No. 4. April, 1937. *p.* 230.
Brief abstract of paper describing experiments on treating air washer water for reducing bacterial content; the ideal germicide; applications.

Graphical Method for the Design of Exhaust Systems, by Arthur Nutting
Vol. 9, No. 1. January, 1937. *p.* 21.
Chart eliminates arithmetical calculations in design of exhaust systems by permitting friction losses and air quantities to be plotted graphically; basis of chart; detailed explanation and typical example showing use; theory of method; factors involved in exhaust system design; full page two color reproduction of chart.

Guest Room Air Conditioning Expected to Create Hotel Business
Vol. 9, No. 5. May, 1937. *p.* 308.
Four St. Louis, Mo., hotels have air conditioned guest rooms; brief description and cost; competition will not cancel benefits of air conditioning.

Hospital Air Conditioning Requirements Outlined
Vol. 9, No. 10. October, 1937. *p.* 607.
Review of article by Dr. C. A. Mills on the more important principles of hospital air conditioning; summer and winter requirements; cooling operating rooms; air cleaning; recirculation; radiant heating and cooling.

Hospital Air Conditioning System Maintains Low Relative Humidities, by A. J. Lawless
Vol. 9, No. 3. March, 1937. *p.* 155.
Corey Hill hospital, Brookline, Mass., completely air conditioned for treatment of patients suffering from arthritis or other rheumatic fevers; lower than usual relative humidities necessary and no general air recirculation; design requirements; air distribution scheme; central conditioning plant; operation of lithium chloride dehumidifier; three control zones; advantages of method used; schematic drawing of system.

Hotel Air Conditioning Visualized
Vol. 9, No. 3. March, 1937. *p.* 151.
Diagram visualizing total number of rooms in U. S. hotels and number now air conditioned; similar information for public and leased spaces in hotels.

How Can We Stop Corrosion of Our Air Conditioning Equipment?
Vol. 9, No. 7. July, 1937. *p.* 422.
Reader's question on corrosion in ammonia refrigeration plant used in conjunction with industrial air conditioning system; methods tried for control of acidity of water; treatment of water recommended; use of dichromate; concentration; discussion of question by C. M. Sterne; tests made on carry-over; proper pH to maintain.

How Much Air Conditioning?, by William P. Rock
Vol. 9, No. 5. May, 1937. *p.* 309.
Survey of ultimate market for summer air conditioning in Chicago and its possible effect on the power company; number of present installations and estimated number of future installations; present and future air conditioning kilowatts and kilowatthours.

How Should These Offices Be Air Conditioned?
Vol. 9, No. 12. December, 1937. *p.* 728.
Question on winter and year around air conditioning of typical suite of offices; readers invited to submit recommendations for publication.

How to Avoid Trouble on Cooling Jobs With Evaporators Above Condensers, by William Goodman
Vol. 9, No. 3. April, 1937. *p.* 221.
(Part 1); general discussion of problem; pressure in a vertical "Freon" pipe line; saturation pressures of "Freon"; how to insulate; computing pressure at any point in line; example; chart for finding final gage pressure at top of vertical pipe line of liquid "Freon".

How to Avoid Trouble on Cooling Jobs with Evaporators Above Condensers, by William Goodman
Vol. 9, No. 5. May, 1937. *p.* 303.
(Part 2); selecting expansion valves; expansion valve ratings; example showing computations for pressure drop in "Freon" pipe lines; effect of refrigerant density on valve capacity; chart for density of mixtures of liquid "Freon" and vapor; examples showing method of solution of problems.

How to Avoid Trouble on Cooling Jobs With Evaporators Above Condensers, by William Goodman
Vol. 9, No. 6. June, 1937. *p.* 355.
(Part 3); methods of preventing liquid from flashing into vapor—subcooling, use of a pump, eliminating vertical liquid line, use of a heat exchanger; no loss of refrigerating capacity when using heat exchanger; diagrams showing various methods; chart for finding percentage of liquid by weight in mixture of "Freon" liquid and vapor.

How to Solve Heat Transfer Problems, by William Goodman
Vol. 9, No. 1. January, 1937. *p.* 11.
(Part 1); information needed on use of heat transmission coefficients; limitations of the basic formula; three main divisions of problems; the various classes of problems; condensing or vaporizing fluids; table of data which facilitates solving problems; curves showing principle of heat transfer when one fluid is condensing or vaporizing; examples showing detailed solution of problems.

How to Solve Heat Transfer Problems, by William Goodman
Vol. 9, No. 2. February, 1937. *p.* 89.
(Part 2); solution of heat transfer problems involving parallel flow; formula for parallel flow and examples showing use; chart illustrating temperature changes which occur in both fluids as they flow past the heat transfer surface.

How to Solve Heat Transfer Problems, by William Goodman
Vol. 9, No. 3. March, 1937. *p.* 165.
(Part 3); solution of heat transfer problems involving counterflow; formulas; examples showing solutions in detail; diagrams illustrating for counterflow temperature changes which occur in both fluids; appendix showing derivation of formulas.

How to Solve Heat Transfer Problems, by William Goodman
Vol. 9, No. 3. March, 1937. *p.* 179.
Data sheets summarizing series of three articles on solving heat transfer problems; formulas; illustrative example; tabular data facilitating solution; diagrams illustrating temperature changes that occur in the various types of problems. Also see page 146, back section, April, 1937, issue.

Ice Cools New Apartment Building, by E. O. Young (with Francis A. Westbrook)
Vol. 9, No. 8. August, 1937. *p.* 484.
Method of cooling Larchmere-Moreland apartment building in Cleveland, Ohio; description of ice using cooling units; cost of installation; detail drawings of unit.

Intake Louvers Are of Stainless Steel
Vol. 9, No. 12. December, 1937. *p.* 736.
Brief description and illustration of penthouse on S. H. Kress & Co. building, New York, N. Y.; stainless steel air intake louvers fabricated by oxy-acetylene welding.

Large Hotel Air Conditioning Job, by John B. Hewett
Vol. 9, No. 3. March, 1937. *p.* 160.
Description of air conditioning of Harrington hotel, Washington, D. C.; design conditions and construction characteristics; shades and insulation reduce heat gain; system of indirect central type using well water and condensing units; operation and control of the system; zone control; installed cost; cost of operation and depreciation; operating results; psychrometric chart and design of cooling coils; air distribution.

Looking Ahead in Railroad Air Conditioning, by C. C. Elmes
Vol. 9, No. 9. September, 1937. *p.* 549.
Number of railroad passenger cars and number of those air conditioned; studies made by Association of American Railroads; future developments in railroad air conditioning; power requirements; types of systems; control; air cleaning devices; survey of passenger reactions to air conditioning.

Low Pressure Exhaust Steam Chills Water for Building Air Conditioning
Vol. 9, No. 6. June, 1937. *p.* 370.
Steam jet refrigeration air conditioning installation at Otis building, Chicago, Ill.; building generates own power; principle of steam jet vacuum cooling; description and illustrations of equipment at Otis building; four spray type dehumidifier units; air handling equipment.

Modernized with Air Conditioning, by Frank A. Merrill (with Francis A. Westbrook)
Vol. 9, *No.* 5. *May,* 1937. *p.* 306.
Modernization of Rice Building, Boston, Mass.; design of air conditioning system; air circulation; advantages of air conditioning; conditions maintained.

New Charts Simplify Splitter Design, by R. D. Madison
Vol. 9, *No.* 3. *March,* 1937. *p.* 152.
Reducing pressure losses in short radius elbows with splitters; charts for design of splitters; use of charts.

New Idea in Air Conditioning
Vol. 9, *No.* 5. *May,* 1937. *p.* 294.
Illustrations of manufacture of compressors for new central refrigeration plant furnishing chilled water for air conditioning several buildings in Washington, D. C.; chilled water piped through underground mains.

Office Building Air Conditioning Pays Health Dividends
Vol. 9, *No.* 5. *May,* 1937. *p.* 305.
Survey showing health advantages of air conditioning of Tribune Tower, Chicago; reduction in absenteeism due to illness; chart showing days lost by employees before and after air conditioning.

Office Building Cleans Air Electrically
Vol. 9, *No.* 11. *November,* 1937. *p.* 676.
Installation of electrostatic precipitators in Field building, Chicago, Ill.; capacity; computation of dirt that will be removed; principle of operation of electrical precipitation unit, with illustrations and diagrams; industrial uses; recovery of glaze in automatic glaze spraying machines.

Owner's View of Air Conditioning, by Arthur Behrstock
Vol. 9, *No.* 9. *September,* 1937. *p.* 555.
Experiences of Walgreen Drug Co. with air conditioning; number of stores air conditioned and investment in air conditioning; advantages; problems in cooling the drug store; new Miami store; sales increases attributed to air conditioning.

Owner's View of Air Conditioning, by J. J. Cogan
Vol. 9, *No.* 11. *November,* 1937. *p.* 664.
Experience of R. H. Macy & Co. (department store) with air conditioning; space air conditioned and investment; 1500 tons of refrigeration; centrifugal refrigeration machines driven by steam turbines; operating policy; balance with outside conditions; advantages of air conditioning department stores.

Plant Motor Survey Pays, by R. W. Orth
Vol. 9, *No.* 1. *January,* 1937. *p.* 49.
Example of value of survey of plant electrical conditions; method of making tests.

Practical Air Conditioning Laboratory Designed to Yield Information on Control and Other Subjects, by J. E. Haines
Vol. 9, *No.* 1. *January,* 1937. *p.* 41.
Description of air conditioning system for executive offices of Minneapolis-Honeywell Regulator Co.; believed to be one of the most complete experimental systems in the world; detailed discussion of controls; central control panel and instrument board; schematic diagram of one of the systems; installation to be used in determining comfort zone and studying air distribution and filtration.

Practical Standards for Air Conditioning Calculations, by W. S. Bodinus
Vol. 9, *No.* 5. *May,* 1937. *p.* 281.
(Part 1); elementary information on air conditioning for beginning air conditioning engineers; review of basic principles; definitions of dry bulb temperature, dew point temperature, absolute humidity, relative humidity, wet bulb temperature, total heat, air volume, etc.; formulas.

Practical Standards for Air Conditioning Calculations, by W. S. Bodinus
Vol. 9, *No.* 6. *June,* 1937. *p.* 367.
(Part 2); sensible heat; formulas; air distribution and temperature differential; types of air outlets.

Practical Standards for Air Conditioning Calculations, by W. S. Bodinus
Vol. 9, *No.* 7. *July,* 1937. *p.* 415.
(Part 3); description and reproduction of Carrier psychrometric chart; examples showing use; total heat of air; change in relative humidity; vapor pressure and absolute humidity.

Practical Standards for Air Conditioning Calculations, by W. S. Bodinus
Vol. 9, *No.* 8. *August,* 1937. *p.* 488.
(Part 4); meaning of the term latent heat; latent heat load in air conditioning; air required to pick up latent heat; total heat load; formulas and examples; table showing properties of saturated water vapor with air.

Practical Standards for Air Conditioning Calculations, by W. S. Bodinus
Vol. 9, *No.* 9. *September,* 1937. *p.* 553.
(Part 5); outside air requirements and refrigeration load; quantity of outside air required per person for various spaces; method of making calculations; method of computing refrigeration load; bypass system; refrigeration requirements with and without bypass compared.

Practical Standards for Air Conditioning Calculations, by W. S. Bodinus
Vol. 9, *No.* 10. *October,* 1937. *p.* 632.
(Part 6); the survey and general procedure; items that should be included on air conditioning survey form.

Practical Standards for Air Conditioning Calculations, by W. S. Bodinus
Vol. 9, *No.* 11. *November,* 1937. *p.* 693.
(Part 7); illustrative example of air conditioning of tavern and club room worked out in detail; heat calculations; heat load; bypass arrangement and air quantity; duct layout and sizes.

Printers Need Air Conditioning
Vol. 9, *No.* 8. *August,* 1937. *p.* 124 (*back section*).
Summary of article on advantages of air conditioning printing plants; typical installations and specific use of air conditioning; comparisons with operation before air conditioning was applied.

Problem of Condenser Water for Large Air Conditioning Plants, by E. Vernon Hill
Vol. 9, *No.* 4. *April,* 1937. *p.* 233.
Central district water supply system of Chicago; capacity; map; sewer system; solution of problem of providing and removing condensing water for air conditioning plants; amount of water required; details of suggested condenser water connection to return water to supply main; benefits to be derived by using suggested method.

Pumping Head on Air Conditioning Systems Reduced by Using Siphon, by William Goodman
Vol. 9, *No.* 7. *July,* 1937. *p.* 418.
(Part 1); general discussion of type of installation article applies to; reduction in head on pump; pressure at top of vertical discharge pipes; design of vertical discharge pipes; formula and its use; diagrams of installations.

Pumping Head on Air Conditioning Systems Reduced by Using Siphon, by William Goodman
Vol. 9, *No.* 8. *August,* 1937. *p.* 477.
(Part 2); long vertical drop of discharge pipes; when a pump may be omitted in installations of the type discussed; location of automatic valves; filling piping system with water; continuity of operation of system.

Put Your Air Conditioning Plant in Shape for Summer Operation, by Rush D. Touton
Vol. 9, *No.* 5. *May,* 1937. *p.* 291.
Summer months represent period of maximum load on air conditioning plants; importance of putting plant in condition for efficient operation; inspect the building structure; air distribution system; test the refrigeration plant; heat transfer surfaces; off-peak storage; air washers; controls of major importance.

Rational Psychromatics, by E. Vernon Hill
Vol. 9, *No.* 10. *October,* 1937. *p.* 621.
Proposed new temperature scales simplify air conditioning calculations; use of a psychrometer with the new scales; a heat unit psychrometric chart; use of chart in solving problems in air mixtures, cooling, and determining the heat ratio; reproduction of the simplified chart.

Rayon and Air Conditioning, by L. L. Lewis
Vol. 9, *No.* 6. *June,* 1937. *p.* 347.
(Part 1); detailed description of manufacture of rayon; viscose process; flow sheet; temperature and humidity requirements for each step; year round air conditioning essential.

Rayon and Air Conditioning, by L. L. Lewis
Vol. 9, *No.* 7. *July,* 1937. *p.* 427.
(Part 2); continuation of description of various steps in the manufacture of rayon by the viscose process; temperature and humidity requirements; acetate and celanese process; weaving and other uses of synthetic yarns; air conditioning requirements of the processes.

Refutes Idea That Air Conditioning Will Cause Water Shortage
Vol. 9, *No.* 11. *November,* 1937. *p.* 720.
Typographical error in recent government report on water requirements of air conditioning plants; probable water consumption for air conditioning less than one per cent of total water requirements of U. S. cities.

Restaurant Presents Peculiar Heat Gain Problem, by Lester T. Avery
Vol. 9, *No.* 2. *February,* 1937. *p.* 105.
Solutions to problem of removing heat from restaurant equipment; insulation; air delivery in restaurant; special precautions where exhaust system is connected in kitchen; providing make-up air.

Retail Store Air Conditioning Surveyed
Vol. 9, *No.* 10. *October,* 1937. *p.* 602.
Review of current issue of "Air Conditioning Trends"; how air conditioning aids in solution of retail store problems; factual basis for approaching problem of selling air conditioning to department stores; example of how air conditioning increases store profits; use of air conditioning by chain stores.

Rule-of-Thumb for Scientific Duct Design, by Henry G. Schaefer
Vol. 9, *No.* 11. *November,* 1937. *p.* 678.
Simplified method of designing ducts; comparison with other methods; use of chart and tables; example.

School Administration Building Is Air Conditioned
Vol. 9, *No.* 9. *September,* 1937. *p.* 556.
Brief description of year around air conditioning system for school administration building at Fresno, Calif.

Show Window Ventilation, by Lester T. Avery.
Vol. 9, *No.* 12. *December,* 1937. *p.* 741.
Show windows need ventilation to prevent condensation, keep temperatures within reasonable limits, keep out dirt; description of system for show windows at Cleveland Electric Illuminating Co.; amount of lighting and heat gain from lights; system comprises supply and exhaust fans and filters; method of operation and control; isometric diagram.

Silica Gel Air Conditioning System Serves Rotogravure Printing Plant, by Herbert E. Ryerson
Vol. 9, *No.* 8. *August,* 1937. *p.* 497.
Description of rotogravure printing process; illustrations of various steps; silica gel air conditioning system at Kable Brothers Co., Mt. Morris, Ill.; flow diagram for air conditioning system; conditions maintained; operation of system; typical detail of branch take-off from main duct; brief description of similar system for cough drop manufacturing plant (F & F Laboratories, Inc., Chicago, Ill.).

Silicosis and Allied Disorders
Vol. 9, *No.* 2. *February,* 1937. *p.* 88.
Program for protecting health of industrial workers and plan of medical research for curbing industrial disease recommended to Air Hygiene Foundation; outline of report for guidance of employers; comments amplifying report; nine things definitely known regarding silicosis.

Simple Way to Analyze Performance of Compressor-Evaporator Combinations, by William Goodman
Vol. 9, *No.* 12. *December,* 1937. *p.* 737.
When air conditioning compressors and evaporator coils are connected, they act as a single unit and the operating conditions of one affect the other; why compressor's capacity varies with suction pressure; why coil capacity varies; combining characteristic curves for compressors and coils; effect of varying air conditions and air velocities; effect of compressor speed; use of two coils and one compressor; function of back pressure valve for maintaining constant pressure in evaporator; how back pressure valve affects capacity of system; typical characteristic curves for "Freon" compressors and coils.

Simplified Method for Solving Air Washer Problems, by Dr. J. R. Zwickl
Vol. 9, *No.* 9. *September,* 1937. *p.* 557.
Cooling air by spray type coolers or air washers; equation for heat balance; water requirements; types of air washers;

graphic methods for solving single stage air washer problems; counterflow two stage, and two stage split spray air washer problems; curves and examples.

Statler Service at St. Louis Includes Air Conditioned Guest Rooms

Vol. 9, No. 1. January, 1937. p. 50.

Brief description of air conditioning system at Hotel Statler, St. Louis, Mo.; water chilled by direct expansion ammonia; water circulating pumps and coolers; room cooling units; guest can control unit.

Sterilizing Air, by A. R. Dennington

Vol. 9, No. 5. May, 1937. p. 288.

Excerpts from recently presented paper; experimental installation of sterilizing lamp at Duke University hospital; tests made; results; possible future applications.

This Air Conditioner Installation Is Noisy, by Samuel R. Lewis

Vol. 9, No. 9. September, 1937. p. 544.

Answer to reader's question about noisy suspended type air conditioner; sketch of installation; recommendations for improvement; use of sound absorbing material.

Treatment of Disease by Air Conditioning to Be Studied by A.S.H.V.E. in 1937 Research, by Brewster S. Beach

Vol. 9, No. 1. January, 1937. p. 40.

Brief description of research on treatment of diseases by air conditioning to be conducted by A.S.H.V.E.; summary of research investigations of A.S.H.V.E.

Unique Air Conditioning System Serves New Industrial Building, by Robert E. Hattis

Vol. 9, No. 2. February, 1937. p. 97.

Windowless, completely air conditioned building for research laboratories and offices of National Aluminate Corp., Chicago, Ill.; air conditioning system of novel design; why windowless construction was adopted; air conditioning essential; details of installation—equipment for pumping cool well water to coils, pumping and supplying hot water, controlling flow of water to coils; heat losses and heat from lights compared; power requirements and cost of operation of system; basement plan and section view showing duct layout.

Units Mounted Above Stage Air Condition Movie House

Vol. 9, No. 10. October, 1937. p. 617.

Brief description of method of installing air conditioning in Isis theater, Fort Worth, Texas.

University of Illinois Installs New Experimental Conditioning Equipment, by William H. Severns and M. K. Fahnestock

Vol. 9, No. 4. April, 1937. p. 227.

Detailed description of installation of air conditioning equipment for experimental and research use; restricted duct sections for determining air velocities; damper and temperature controls; elevation and plan drawings of system; summary of equipment; types of problems for which apparatus is suitable.

What Air Conditioning Means to the Retailer, by Verda Jensen

Vol. 9, No. 1. January, 1937. p. 48.

Trend in air conditioning drug stores; number of installations in Chicago; Sutliff and Case drug store, Peoria, Ill.; increase in sales after air conditioning; other advantages; problems in air conditioning drug stores.

What Does Air Conditioning Mean to Industry? by Samuel R. Lewis

Vol. 9, No. 2. February, 1937. p. 106.

Examples of what air conditioning means in various industrial processes—food preparation, manufacture of pencil refills, manufacture of chocolates, printing, manufacture of cosmetics; preventing condensation on steel in storage.

What of the Future of Air Conditioning? by Walter L. Fleisher

Vol. 9, No. 1. January, 1937. p. 1.

Importance of air conditions on health recognized by ancients; what air conditioning is; interesting analogy between bakery and comfort air conditioning; inconsistencies in present air conditioning practice; human being an intricate combustion machine; use of evaporative cooling methods; radiant heating and cooling; map of midsummer wet bulb temperatures for United States; table of summer temperatures; A.S.H.V.E. comfort or effective temperature chart.

What's the Cost of Air Conditioning? by Rex E. Hieronymus

Vol. 9, No. 5. May, 1937. p. 295.

Analysis of air conditioning system for two-story taxpayer type building, Chicago, Ill.; partial list of mechanical equipment; type of air conditioning system; reasons for its selection; putting plant in operation; cost analysis of air conditioning for heating season and cooling season; comparison of cost with ordinary heating system; diagram showing essential elements of system.

Heating

Accurate Method for Control of Heating Fuel Costs, by W. S. Bard

Vol. 9, No. 8. August, 1937. p. 473.

Methods of recording consumption of steam or fuel for heating institutional building groups; applying statistical methods to month-by-month comparisons; normal consumption curves; quartile deviation; deviation ratio; monthly report; yearly report; monthly steam consumption curves for buildings with various types of normal steam consumption curves; effect of other than heating uses of steam in consumption trends.

After the Flood—Restoring Equipment to Service, by Samuel R. Lewis

Vol. 9, No. 2. February, 1937. p. 108.

Cleaning boilers, piping, tanks, pumps; brick work and concrete; motors; bearings; examining boilers for cracks; insulation; protecting tanks against damage from flood.

American Practice in Panel Heating, by Leon L. Munier

Vol. 9, No. 7. July, 1937. p. 424.

General description of advantages of panel heating and design of systems; lower air temperatures maintained; installation of panels; determining panel area; method of plastering important; the patent situation; use of radiant heat in greenhouses and for plant culture outside of building.

Automatic Weigher Records Coal for Heating School

Vol. 9, No. 6. June, 1937. p. 350.

Equipment for weighing and automatically recording coal used for heating new Southwestern high school, St. Louis, Mo.

Btu Required for Heating Air

Vol. 9, No. 11. November, 1937. p. 684.

Table showing quantity of heat in Btu required to raise one cubic foot of air through any given temperature interval.

Combustion Chambers for Oil Fired Boilers, by Kalman Steiner

Vol. 9, No. 6. June, 1937. p. 351.

General data on combustion chambers for oil fired boilers; heat release per cubic foot of volume; rules for firebox construction; shape of combustion chamber; combustion volume a controversial point; secondary air port area; diagrams and tables showing combustion chamber dimensions for firebox construction, for cast iron sectional, firebox, Scotch marine, steel tubular and horizontal return tubular boilers.

Controls, by C. L. Rinquist (Reference Sheet 5)

Vol. 9, No. 1. January, 1937. p. 39.

Diagrams of three typical control arrangements for heating, ventilating and humidifying systems; cycle of operation of each.

Electric Heating System Defrosts Store Windows, by W. F. Mainguy

Vol. 9, No. 11. November, 1937. p. 675.

Problem of defrosting store windows in Quebec; experiences with electric tubular heater; unit heaters; method adopted comprises perforated duct along base of window through which is blown electrically heated air; wattage requirements.

Glycerine Solves Boiler Scale Problem

Vol. 9, No. 2. February, 1937. p. 104.

Glycerine found useful in preventing or retarding formation of boiler scale; method of use; results of tests.

Heating a Bunkhouse, by Samuel R. Lewis

Vol. 9, No. 4. April, 1937. p. 148 (back section).

Reader's question on heating industrial plant bunkhouse answered; plan and section; design temperature; heating service water by condensation; radiation and piping; sizing steam reducing valve.

Heating Fuel Consumption Data, by Kalman Steiner

Vol. 9, No. 10. October, 1937. p. 618.

General discussion of methods of making comparisons of heating fuel consumption data; complications; measure of good performance indefinite; steam requirements for heating office buildings; effect of design temperature; data on fuel requirements for heating theaters; allowing for differences in climate; variations in fuel use.

Heating System Control Methods and Reducing Fuel Consumption, by Kalman Steiner

Vol. 9, No. 3. March, 1937. p. 170.

Typical methods of controlling heating systems that operate exclusively upon the heating system; firing device left under control of pressurestat on boiler; radiator orificing; correcting piping defects in heating systems; fuel consumption estimates and comparison; listings of economies which can be effected through operation and maintenance of heating plants, and by changes in heating systems and building construction.

Heating System Control Methods for Reducing Fuel Consumption, by Kalman Steiner

Vol. 9, No. 2. February, 1937. p. 85.

Necessity of control for heating systems; general methods of control, particularly with oil burners; detailed descriptions of four methods of control using available commercial equipment.

Heat Recovery System to Reduce Laundry Steam Consumption, by V. F. Alley

Vol. 9, No. 5. May, 1937. p. 308.

Diagram and brief description of heat recovery system for laundry; incoming city water heated in primary and secondary economizers.

How Heat and Ventilate a Garage? by Samuel R. Lewis

Vol. 9, No. 7. July, 1937. p. 423.

Answer to reader's question on method of heating and ventilating office space in a garage; suggested damper arrangement.

Improving Heating Plants, by Rex E. Hieronymus

Vol. 9, No. 5. May, 1937. p. 302.

Brief remarks on how to go about improving operation of heating plants; program of improvement should never be completed.

Investigations by Federal Bureaus of Texas School Explosion Summarized

Vol. 9, No. 6. June, 1937. p. 358.

Investigations of school explosion at New London, Texas, by U. S. Bureau of Mines; recommendations of specialists; report of Dr. David J. Price; school heated by gas fired radiators.

Making Steam Do Double Duty, by F. J. Vonnchen

Vol. 9, No. 5. May, 1937. p. 289.

Possibilities of improving plant heat balance by using steam engines for driving fans and compressors; adaptability of the steam engine; operating costs; study of a steam engine driving a ventilating fan at a school; types of applications.

New Type of Unit Furnishes Heat and Power to Ford's Valve Plant

Vol. 9, No. 10. October, 1937. p. 608.

"Steamotive"; steam electric generating unit at Northville, Mich., valve plant of Ford Motor Co.; operating data on boiler efficiency; water content; unit is oil fired; design of unit and advantages; auxiliaries.

New York's New Building Code, by Walter L. Fleisher

Vol. 9, No. 11. November, 1937. p. 682.

Brief remarks on provisions of new New York City building code affecting heating, ventilating, air conditioning, and its allied branches; quotations from code; index for ventilation of various spaces.

Performance of Heaters and Coolers Under Changed Operating Conditions, by Bayard P. Fonda

Vol. 9, No. 4. April, 1937. p. 237.

Method of calculating performance of air heating and cooling surface when operating conditions are changed; formulas; examples; applying method to other gases or liquids.

Selecting the Right Size Heating Boiler, by Sabin Crocker

Vol. 9, No. 6. June, 1937. p. 373.

Articles on heating boiler selection summarized in data sheet form; factors affecting selection; absorbing capacity of boiler surface; manufacturers' ratings; approximate heat emission, condensation factors, and equivalent ratios for various types of radiating surfaces; conversion factors for computing heat

emitted by radiation and equivalent known radiation; chart showing variation with pipe size of rate of heat transfer through various thicknesses of 85 per cent magnesia insulation and through bare pipe.

Selecting the Right Size Heating Boiler, by Sabin Crocker
Vol. 9, No. 7. July, 1937. p. 437.
Information on selecting heating boilers in data sheet form; computation of boiler load due to piping; table of heat emission from horizontal bare iron or steel pipes in air at 70 F; graph showing heating power of brass and iron pipe coils in water storage tanks.

Selecting the Right Size Heating Boiler, by Sabin Crocker
Vol. 9, No. 8. August, 1937. p. 501.
Information on selecting heating boilers in data sheet form; computation of load due to domestic hot water requirements; table of water heating loads vs. temperature rise for various rates; satisfactory warming up period; table showing warming up allowance for boilers for various loads.

Selecting the Right Size Heating Boiler, by Sabin Crocker
Vol. 9, No. 9. September, 1937. p. 565.
Information on heating boiler selection in data sheet form; the warming up problem; computing the time required for warming up; tables of weights of pipe and fittings, weights of boilers and water content, and weight, of cast iron radiators.

Selecting the Right Size Heating Boiler, by Sabin Crocker
Vol. 9, No. 10. October, 1937. p. 611.
Information on selection of heating boilers in data sheet form; use of performance curves; fuel burning rate; grate area; typical values for square feet of boiler heating surface per square foot of grate area; combustion rates for coal fired boilers; recommended setting heights for stoker fired boilers.

Selecting the Right Size Heating Boiler, by Sabin Crocker
Vol. 9, No. 11. November, 1937. p. 687.
Information on heating boiler selection in data sheet form; rule for furnace volume; oil fired boilers; gas fired boilers; furnace heights for stoker fired boilers.

Setting Up a Heat Economy Program, by Rex E. Hieronymus
Vol. 9, No. 1. January, 1937. p. 25.
In most buildings heating represents largest single commodity purchase after electricity and payroll; economic purchase and utilization of heat units a problem which naturally divides into two phases; how to set up and carry forward program to assure economic and efficient heating service; recording temperatures; determining average monthly space temperature; importance of daily records; don't be alarmed at occasional complaints; basement economy important; checking fuels on "Btu per dollar" basis; automatic coal burning equipment; improvement in economy due to stokers over a period of years; importance of instruments for keeping track of fuel, steam, feedwater, and flue gas; if inefficient equipment is being operated, new equipment is really being paid for whether the building has it or not; high points of one economy program for a group of buildings; effect of CO_2 on fuel economy.

Sewage Disposal Plant Makes Own Fuel
Vol. 9, No. 12. December, 1937. p. 732.
La Crosse, Wis., sewage disposal plant uses gas from digester tanks for heating building and for process requirements; gas used in internal combustion engine; jacket water, heated by exhaust, piped to unit heaters and convectors.

Superheated Water System Heats New Swiss Buildings, by R. Ruegg
Vol. 9, No. 4. April, 1937. p. 224.
New cantonal administration buildings at Zurich, Switzerland; general discussion of the heating problem; method of heating the water; diagram of connections for supplying superheated water from district heating power station; temperature regulation; the distribution system and the building heating systems; charging for heat.

Technical Problems in Analyzing Fuel Consumption, by W. S. Bard
Vol. 9, No. 9. September, 1937. p. 541.
Heating steam consumption determined by three groups of factors; variables involved; application of statistical method of comparing fuel consumption data; mathematical treatment of curves; the degree day; advantages and disadvantages of the factor "pounds of steam per degree day"; the factor "pounds of steam per degree day per thousand cubic feet of building space"; limitations in accuracy of factor.

Turbines for Heat Balance Purposes, by S. O. Maxwell
Vol. 9, No. 5. May, 1937. p. 290.
Possibilities of obtaining economical power by using steam turbines to drive centrifugal refrigeration machines; characteristics; various installations.

Unit Heaters Speed Drying of Cleaned Garments, by Ben Maxwell
Vol. 9, No. 4. April, 1937. p. 236.
Installation of unit heaters in dry cleaning plant for drying solvent cleaned and laundered garments; location of units; advantages of method.

Ventilating and Heating Store Windows, by Richard Brunel
Vol. 9, No. 8. August, 1937. p. 495.
Remarks answering reader's question for information on ventilating and heating requirements of show windows; conditions in a closed show window; frosting of windows; high summer temperatures; lighting load; methods of preventing condensation on windows.

What's the E.D.R. of Indirect Heating Surface? by William S. Downs
Vol. 9, No. 11. November, 1937. p. 667.
Distinction between actual heating surface area and equivalent direct radiation; heating steam requirements of Irving Trust Co. building, New York, N. Y.; computing equivalent direct radiation of blast heating coils; use of information in comparing steam consumption data.

World's Biggest Building Installs New Heating and Combustion Control, by W. A. Stahl
Vol. 9, No. 12. December, 1937. p. 721.
Size of Merchandise Mart, Chicago, Ill.; no zone or combustion control when built; first step installation of flow meters; heating system and combustion control and instruments; payments based on fuel savings; terms of contract; correction factors for occupancy; eight control zones; outside thermostats and reducing valves; controlling stokers; variable speed stoker drives; indicated fuel saving 22 per cent.

Piping

Accessibility of Service Piping Features Aircraft Assembly Plant
Vol. 9, No. 4. April, 1937. p. 242.
New Seattle, Wash., plant of Boeing Aircraft Co.; piping services in tunnels; method of heating; fire protection; unit heaters.

Correct Piping Layout Important for Diesel Engine Installations, by C. T. Baker
Vol. 9, No. 7. July, 1937. p. 420.
General recommendations for piping for diesel engine installations; exhaust piping; water and oil piping; use of cooling towers; pumps; filtering intake air.

Corrosion of Condensate Return Lines, by J. H. Walker
Vol. 9, No. 6. June, 1937. p. 366.
Underground condensate return lines at a university being corroded; brief answer to the question; recommendations for testing for corrosion and making water analysis.

Creep Testing of Metals, by J. J. Curran
Vol. 9, No. 9. September, 1937. p. 551.
Importance of creep of metals; creep requirements which must be met by valves and fittings; creep rate; creep testing; the specimen; the machine; types of electric furnaces used.

Flow Meter Installation, by Louis Gess and J. O. Feldmark
Vol. 9, No. 2. February, 1937. p. 103.
Location of flow meter orifice; use of straightening vanes; diagrams of two types of vanes; measuring pulsating flow; method of eliminating pulsations caused by reciprocating water pumps.

Ford Centralizes Control of New Gas Distribution Piping
Vol. 9, No. 7. July, 1937. p. 411.
Piping is an industrial transportation system; electrically operated control system for new gas distribution piping at Rouge plant, Ford Motor Co., Dearborn, Mich.; description of system; diagram of main gas consuming units and control valves; centralized control essential; how control system operates.

Formulas for Stresses in Bolted Flanged Connections, by E. O. Waters, D. B. Wesstrom, D. B. Rossheim and F. S. G. Williams
Vol. 9, No. 6. June, 1937. p. 363.
(Part 1); increasing importance of methods of design of flanged piping connections; review of earlier work; basis of the present study; analysis of stress distribution; types of flanges to which formulas apply.

Formulas for Stresses in Bolted Flanged Connections, by E. O. Waters, D. B. Wesstrom, D. B. Rossheim and F. S. G. Williams
Vol. 9, No. 7. July, 1937. p. 431.
(Part 2); formulas and discussion of design of flanges; tapered hub flange without hydrostatic pressure; development of design formulas; graphs showing values for use in formulas.

Formulas for Stresses in Bolted Flanged Connections, by E. O. Waters, D. B. Wesstrom, D. B. Rossheim, and F. S. G. Williams
Vol. 9, No. 8. August, 1937. p. 485.
(Part 3); tapered hub flange with hydrostatic pressure and no bolt load; illustrative problems; graphical results of examples.

Formulas for Stresses in Bolted Flanged Connections, by E. O. Waters, D. B. Wesstrom, D. B. Rossheim, and F. S. G. Williams
Vol. 9, No. 9. September, 1937. p. 545.
(Part 4); fillets and their design; comparison of various formulas; tests; bibliography on flange design.

How Do You Know the Bolts Are Tight and Not Too Tight?
Vol. 9, No. 8. August, 1937. p. 476.
Anonymous comment on tightening bolts for flange connections; need for a torque wrench.

How Pipe Is Made
Vol. 9, No. 3. March, 1937. p. 154.
Brief description of various processes for manufacturing pipe, including seamless process, rotary rolled seamless process, lap weld process and butt weld process; operations in converting round solid bar to seamless pipe.

How Steam Storage Can Be Applied to Process Steam Piping Systems
Vol. 9, No. 11. November, 1937. p. 685.
Use of steam accumulator at a typical plant; installation; method ideal for variable loads; prevents excessive pressure drop in piping; diagrams of steam storage systems for a paper mill and a brewery.

How to Operate Centrifugal Pumps
Vol. 9, No. 4. April, 1937. p. 231.
Information abstracted from "Standards" issued by Hydraulic Institute; priming; priming by foot valve; priming by vacuum pumps; starting and stopping; check list for locating pump troubles of various kinds.

Importance of Design Control for Welded Piping Systems, by T. W. Greene
Vol. 9, No. 2. February, 1937. p. 92.
A.S.A. code for pressure piping and its requirements for minimum thickness of pipe wall for threaded pipe and for welded pipe; maximum allowable working pressures; stress in pipe for different pressures; pressure stresses around nozzles; superimposition of bending stresses; tests of power piping header; stress relieving of piping; weld quality; use of liners.

Improving Plant Piping Systems, by Walter E. Hume
Vol. 9, No. 5. May, 1937. p. 285.
General discussion of importance of improving piping systems; economy in use of steam; inspection of piping; insulation; cost of leaks; use of exhaust steam; auxiliary equipment; expansion of piping; reducing valves.

Measuring Steam Consumption of Paint Drying Coils
Vol. 9, No. 1. January, 1937. p. 188 (back section).
Answer to question on method of determining steam requirements of paint drying coils.

New Data for Refrigeration Piping Design (Ammonia Liquid Line Piping), by R. C. Doremus
Vol. 9, No. 12. December, 1937. p. 725.
Importance of proper ammonia piping; properties of ammonia; piping materials; methods of making joints; welded installations; gaskets; unions; sizing liquid line piping; expansion and shut-off valves; pressure drops in valves; installations where evaporator is above compressor; lubrication; specifications for oil; table of recommended pipe sizes.

New Data for Refrigeration Piping Design ("Freon" Liquid Line Piping), by R. C. Doremus
Vol. 9, No. 8. August, 1937. *p.* 492.
"Freon" liquid line piping; properties of "Freon"; piping materials; recommended liquid line sizes for various tonnages; pressure drop; lubrication; oil recovery; graphs showing pressure drop vs. capacity for liquid "Freon-12" through thermal expansion valves and solenoid shut-off valves.

New Data Aids Refrigeration Piping Design ("Freon" Suction Line Piping), by R. C. Doremus
Vol. 9, No. 9. September, 1937. *p.* 533.
Properties of "Freon" vapor; pressure drops for various tonnage capacities through 100 ft. of copper pipe for saturated gas at 0 F and at 41 F; pressure drop in equivalent length of pipe due to valves and fittings; example of use of data; velocity chart for vapor at various suction temperatures for copper piping of different diameters, in feet per minute per ton of refrigeration; importance of proper pipe sizing.

New Data for Refrigeration Piping Design (Methyl Chloride Liquid Line Piping), by R. C. Doremus
Vol. 9, No. 10. October, 1937. *p.* 603.
Importance of proper design of refrigeration piping; properties of methyl chloride; piping materials; expansion valves; magnetic shut-off valves; lubrication and oil recovery; pressure-temperature curves for ammonia, "Freon 12," and methyl chloride; siutable pipe sizes for liquid lines; pressure drop curves for liquid methyl chloride through thermal expansion valves and solenoid shut-off valves.

New Data for Refrigeration Piping Design (Methyl Chloride Suction Piping), by R. C. Doremus
Vol. 9, No. 11. November, 1937. *p.* 669.
Characteristics of methyl chloride vapor; pressure drops of methyl chloride vapor for various tonnage capacities in copper pipe for saturated gas at 0 F and 41 F; example showing design of piping for large market; tons capacity of suction piping; pressure drop due to valves and fittings; velocity chart for methyl chloride suction vapor at various suction temperatures for copper piping of different diameters, in feet per minute per ton of refrigeration; foolish economy to skimp on piping.

New Method of Studying Erosion Aids Selection of Valve Seat Materials, by Fred R. Venton
Vol. 9, No. 1. January, 1937. *p.* 34.
Erosion of valves; earlier test methods; better method devised and described; test results summarized; specimens classified by crater depths; group classification of specimens according to depth of impression; illustrations of typical specimens; general information on selection of valve seating materials.

Nut and Bolting Materials for High Pressure and High Temperature Piping Service, by Harvey A. Wagner
Vol. 9, No. 3. March, 1937. *p.* 147.
Two specifications recently adopted by American Society for Testing Materials; bolting material; properties of steel; identification symbols; performance of joints at service temperature; creep strength; threads; nut material; checking physical properties; dimensions; identifying marks; comparison of corresponding sizes of American standard regular and heavy nuts; chemical compositions and physical properties of steels for high temperature service; chemical requirements for carbon steel nut material; pitch diameter for 1 in. bolt and nut; Brinell hardness of nuts.

Piping for 3500 Lb Steam, by H. L. Solberg
Vol. 9, No. 6. June, 1937. *p.* 360.
Experimental steam generating unit at Purdue University; can be operated at pressures up to 3500 lb per sq in., maximum steam temperature of 830 F; description of unit; screwed piping connections; flanged connections; performance of joints; ¾ in. throttling valve with ring joints; advantages and disadvantages of various joints.

Proper Installation of Centrifugal Pumps
Vol. 9, No. 5. May, 1937. *p.* 300.
Abstract of standards issued by Hydraulic Institute; location of pump; alignment; grouting; piping and valves; stuffing boxes and packing; bearings; miscellaneous.

Properties of Pipe, by Arthur McCutchan
Vol. 9, No. 4. April, 1937. *p.* 247.
Tables of properties of pipe published in data sheet form; significance of properties tabulated; use of tables.

Properties of Pipe, by Arthur McCutchan
Vol. 9, No. 5. May, 1937. *p.* 315.
Tables of properties of pipe in data sheet form.

Recent Changes in National Piping Standards, by Sabin Crocker and Harvey A. Wagner
Vol. 9, No. 10. October, 1937. *p.* 613.
(Part 1); analysis of recent piping standards; dimensional standards—steel flanged fittings and companion flanges, face-to-face dimensions of flanged valves; welding fittings, screw threads, pipe plugs, flanged ammonia fittings, cast iron pipe flanges and flanged fittings, sprinkler fittings, hose couplings, soil pipe and fittings, wrought iron and wrought steel pipe, code for pressure piping; proposed ring and groove dimensions for carbon steel flanges; tables of ratings for carbon steel flanged fittings and companion flanges with standard facings; table of proposed adjusted ratings for American steel flanged standards when made of carbon-molybdenum steel.

Recent Changes in National Piping Standards, by Sabin Crocker and Harvey A. Wagner
Vol. 9, No. 11. November, 1937. *p.* 659.
(Part 2); development of materials specifications for piping; specifications for pipe, castings, forgings, bolting; chemical and physical properties of alloy pipe materials for high temperature service, and for alloy steel castings materials; chemical and physical properties of alloy steel bolting materials for high temperature service; new specifications for boiler tubes.

Ring Joint—Its Relative Merit and Application, by E. C. Petrie
Vol. 9, No. 4. April, 1937. *p.* 213.
General discussion of problem of maintaining tight flange joints with high pressures and temperatures; comparison of ring joint and flat gasket type; general characteristics of ring joint connection; effective pressure area; results of comparative tests; interpretation of test results and test data; effect of flange thickness, width of ring, shape of ring; determining width of ring section; torque-tress relationship for alloy steel bolts, and coarse threaded bolts; tables of ring dimensions for 150, 300, 400, 600, 900, 1500, and 2500 lb flanges and oil field flanges.

Romans Had a Technique for It (Early Manufacture of Lead Pipe), by F. E. Wertheim
Vol. 9, No. 9. September, 1937. *p.* 561.
Methods used by Romans for early manufacture of lead pipe; illustrations of pipe sections; making joints; etched section of pipe.

Significance of the Reynolds Number
Vol. 9, No. 2. February, 1937. *p.* 102.
Excerpt from address by Prof. B. A. Bakhmeteff; two types of fluid motion; the transition zones; analogy explaining Reynolds number; the Reynolds diagram.

Solving Piping Flow Problems, by William Goodman
Vol. 9, No. 10. October, 1937. *p.* 625.
(Part 1); eliminating cut-and-try methods when using the Reynolds' number; definition of Reynolds' number; modified Reynolds' numbers for finding flow through a pipe and required pipe diameter; friction factor chart; table of various formulas; use of formulas and curves; computing the flow; flow with changing density; viscosities of a few liquids, gases and vapors; table of constants for use in formulas—inside diameters of standard weight steel pipe and type L copper tubing and diameters to the 3/2 and 5th powers.

Solving Piping Flow Problems, by William Goodman
Vol. 9, No. 11. November, 1937. *p.* 689.
(Part 2); eliminating cut and try methods when using the Reynolds' number; formulas and examples; criterion for applying formula; critical pressure in a pipe line; appendix showing derivation of formulas.

Strength and Design of Covers and Flanges for Pressure Vessels and Piping, by T. McLean Jasper, H. Gregersen and A. M. Zoellner
Vol. 9, No. 1. January, 1937. *p.* 43.
(Part 3); comparison of results from formulas and test flanges; variation of external moment with flange thickness and fillet radius; variation of external moment with hub thickness and fillet radius; variation of external moment with flange width; influence of bolt holes and of hub length on hubbed flanges; graphs showing test points and theoretical curves.

Strength and Design of Covers and Flanges for Pressure Vessels and Piping, by T. McLean Jasper, H. Gregersen and A. M. Zoellner
Vol. 9, No. 2. February, 1937. *p.* 109.
(Part 4); bolt loads; relation between flange load per bolt and wrench turning moment for bolts; numerical examples showing design of cover, ring flange and hubbed flange; arrangement of flange and loading equipment in testing machines.

Strength and Design of Covers and Flanges for Pressure Vessels and Piping, by T. McLean Jasper, H. Gregersen, and A. M. Zoellner
Vol. 9, No. 3. March, 1937. *p.* 174.
(Part 5); appendix reporting test results on plaster of paris models; tabulated data on tests of ring flanges and hubbed flanges; illustrations of specimens after testing.

Strength and Design of Covers and Flanges for Pressure Vessels and Piping, by T. McLean Jasper, H. Gregersen and A. M. Zoellner
Vol. 9, No. 4. April, 1937. *p.* 243.
(Part 6); fillet coefficients; location of gasket; curves showing variation of bending moment with distance from junction between ring and hub in small and large hubbed flanges.

Strength and Design of Covers and Flanges for Pressure Vessels and Piping, by T. McLean Jasper, H. Gregersen and A. M. Zoellner
Vol. 9, No. 5. May, 1937. *p.* 311.
(Part 7); history of flange theories; tests on plaster of paris models of hubbed flanges.

Ten Mile Industrial Pipe Line Conveys 8,000,000 Gallons of Water Per Day
Vol. 9, No. 8. August, 1937. *p.* 479.
Brief description of large pipe line for paper mill of Southern Kraft Corp., Georgetown, S. C.; spiral welded pipe 24 in. in diameter; coated; method of laying pipe; couplings.

Valves—a Review of Available Types and Their Features, by F. H. Morehead
Vol. 9, No. 12. December, 1937. *p.* 734.
(Part 1); importance of valves; early types and applications; early gate valve; globe valve with wooden disc and sliding stem; general classification of valves based on flow characteristics and opening and closing mechanisms; general features of globe and gate valves; screwed and flanged ends.

Welded Fabrication of Manifolds and Special Fittings for Piping, by Sabin Crocker
Vol. 9, No. 1. January, 1937. *p.* 15.
Advantage of fabricated parts for high pressure, high temperature welded power plant piping; comparison with cast fittings; various examples described and illustrated: fabrication of welded manifold; mitering and bevelling; reinforcement of branch openings; typical example for reinforcement, with formula for computing minimum pipe wall thickness; importance of sound welds; chart showing limits of sizes of unreinforced openings in cylindrical shells.

Welded Piping System for Handling Syrup
Vol. 9, No. 1. January, 1937. *p.* 187 (*back section*).
Interesting pump and piping system of welded construction at corn syrup products manufacturing plant; number of welds; flow diagram of system.

Welding Society Publishes Standard Welding Symbols
Vol. 9, No. 8. August, 1937. *p.* 487.
Brief description and reproduction of fusion welding symbols adopted by American Welding Society.

Windmills Protect Pipe from Corrosion
Vol. 9, No. 5. May, 1937. *p.* 293.
Counteracting electrolytic corrosion of underground pipe lines by impressing voltage from outside source; method of application; windmills used to generate current.

X-Ray Inspection of Field Welded Pressure Piping, by Herbert R. Isenburger
Vol. 9, No. 6. June, 1937. *p.* 369.
Importance of x-ray inspection of welded piping; feasibility of making examination in the field; method employed on one project; portable x-ray unit.

Journal of American Society of Heating and Ventilating Engineers

January-December, 1937—Vol. 9, Nos. 1-12

Acoustical Terminology, A.S.A. Announces Standard, Feb. 120
Action, A.S.H.V.E. Research Goes Into, Mar. 196
Adapability of Precooling Coils to Air Washer Systems, The, John Everetts, Jr., July. 441
Advisory Committee Appointed for Fifth Exposition, June 407
Air Cleaning Devices, An Alternate Method of Comparing the Dust Arrestance of, Arthur Nutting, Aug. 511
Air Conditioned Office, Summer Cooling Requirements of 275 Workers in an, A. B. Newton, F. C. Houghten, Carl Gutberlet and R. W. Qualley, Dec. 758
Air Conditioning by Low Pressure Steam, Summer and Winter, G. F. Zellhoefer, Apr. 265
Air Conditioning Courses, Heating, Ventilating and, Oct. 643
Air Conditioning Data Sheets, Aug. 512
Air Conditioning Manufacturers to Meet, Refrigerating Machinery and, May. 335
Air Conditioning, Measuring Air Distribution and Grille Performance in, G. L. Tuve, Nov. 700
Air Conditioning Sales, Aug. 510
Air Conditioning School, Aug. 528
Air Conditioning System Use, How Much Power Will an, Anson D. Marston, Aug. 513
Air Conditioning to the Treatment of Disease, Application of, C. P. Yaglou, Oct. 635
Air Conditions for the Manufacturing of Confections, Proper, A. E. Stacey, Jr., Oct. 640
Air Cooling and Dehumidifying Performance of Fin-Tube Units for, G. L. Tuve and C. A. McKeeman, June 379
Air Distribution and Grille Performance in Air Conditioning, Measuring, G. L. Tuve, Nov. 700
Air, Fever Therapy Induced by Conditioned, F. C. Houghten, M. B. Ferderber and Carl Gutberlet, Feb. 115
Air Hygiene Foundation of America, The, Jan. 76
Air Space Insulation, Calculated Over-all Coefficients for Walls with, F. B. Rowley, July. 444
Air Spaces in Frame Construction, Radiation and Convection Across, Gordon B. Wilkes and Carl M. F. Peterson, Aug. 505
Air Supply Outlets, The Noise Characteristics of, D. J. Stewart and G. F. Drake, Jan. 65
Air Washer Systems, The Adaptability of Precooling Coils to, John Everetts, Jr., July. 441
All Aboard for Swampscott, June. 401
Allcut, E. A., and F. G. Ewens, Heat Insulation Tests and Their Application, May. 328
Alternate Method of Comparing the Dust Arrestance of Air Cleaning Devices, An, Arthur Nutting, Aug. 511
Aluminum Foil Insulation, Note on the Testing of, J. D. Babbitt, Sept. 577
Amendment to Constitution and By-Laws, Aug. 525
Analysis of a Bank Building, Cooling Load, John James, Sept. 569
Annual Meeting and 5th Exposition, 44th, July. 468
Annual Meeting in New York, A.S.H.V.E., Nov. 704
Annual Meeting, New York Will Entertain A.S.H.V.E. at 44th, Oct. 653
Annual Meeting of A.S.H.V.E., 44th, Sept. 589
Annual Meeting, Proceedings of the 43rd, Mar. 198
Annual Meeting, Program, 44th, Dec. 771
Annual Meeting, Program, A.S.H.V.E., Jan. 74
Application, Heat Insulation Tests and Their, E. A. Allcut and F. G. Ewens, May. 328
Application of Air Conditioning to the Treatment of Disease, C. P. Yaglou, Oct. 635
Armco Laboratory Opened, Dec. 776
Arrestance of Air Cleaning Devices, An Alternate Method of Comparing the Dust, Arthur Nutting, Aug. 511
A.S.A. Announces Standard Acoustical Terminology, Feb. 120
A.S.H.V.E., 44th Annual Meeting of, Sept. 589
A.S.H.V.E. Annual Meeting in New York, Nov. 704
A.S.H.V.E. Annual Meeting, Program, Jan. 74
A.S.H.V.E. at 44th Annual Meeting, New York Will Entertain, Oct. 653
A.S.H.V.E. Officers Elected in 1937, Feb. 139
A.S.H.V.E. Papers, Reprints of, Sept. 582
A.S.H.V.E. Research, Apr. 273
May. 337
June. 386
July. 459
Aug. 521
Sept. 588
Oct. 651
Nov. 708
Dec. 767
A.S.H.V.E. Research Goes Into Action, Mar. 196
A.S.H.V.E. Semi-Annual Meeting, Come to Swampscott in June, May. 338
A.S.H.V.E. Semi-Annual Meeting, Program, June. 402
A.S.R.E. to Meet at French Lick, May. 340
Axial-Flow Fans, Aug. 519
Babbitt, J. D., Note on the Testing of Aluminum Foil Insulation, Sept. 577
Bank Building, Cooling Load Analysis of a, John James, Sept. 569
Blackmore Family—Heating Engineers, The, Nov. 702
Body and Its Environment, Investigations on the Exchanges of Energy Between the, Charles Sheard and M. M. D. Williams, Mar. 189
Body Heat Loss Through Radiant Means, Control of, C. A. Mills and Cordelia Ogle, Nov. 697
Boyden and Vice-President Gurney to Visit Chapters, President, Apr. 274
Broderick, E. L., A. P. Kratz and M. K. Fahnestock, The Cooling and Heating Rates of a Room with Different Types of Steam Radiators and Convectors, Apr. 251
Broderick, E. L., A. P. Kratz and S. Konzo, Study of Summer Cooling in the Research Residence Using Water at Temperatures of 52F and 46F.
Part 1, May. 319
Part 2, June. 391
Building as Influenced by the Stack Effect, Heating Requirements of an Office, F. C. Houghten and Carl Gutberlet, July. 451
Building, Cooling Load Analysis of a Bank, John James, Sept. 569
Bureau Established for Chapters, Speakers, Sept. 591
Bureau of Mines Continues Survey of American Coals, Aug. 528
Calculated Over-all Coefficients for Walls with Air Space Insulation, F. B. Rowley, July. 444
Candidates Elected, Jan. 84
Feb. 146
Mar. 212
Apr. 280
May. 346
June. 410
July. 472
Aug. 532
Sept. 598
Oct. 657
Nov. 719
Dec. 780
Candidates for Membership, Jan. 82, 83, 84
Feb. 144, 145
Mar. 211, 212
Apr. 278, 279, 280
May. 345, 346
June. 409, 410
July. 470, 471, 472
Aug. 530, 531
Sept. 597, 598
Oct. 656, 657
Nov. 717, 718, 719
Dec. 777, 778, 779, 780
Carnegie Appropriation, Engineers' Council Gets, Jan. 76
Carrier Corporation, W. H. Driscoll Joins, Mar. 207
Carrier Honored by Japanese Engineering Societies, Jan. 75
Celotex Appoints, Sept. 591
Certificate Course at New York University, Sept. 591
Chapter Reports, Jan. 77, 78, 79, 80, 81
Feb. 141, 142, 143, 144
Mar. 208, 209, 210
Apr. 275, 276, 277
May. 341, 342, 343
June. 404, 405, 406
July. 462, 463, 464, 465, 466, 467
Aug. 529
Sept. 590, 591, 592, 593, 594, 595, 596
Oct. 653, 654, 655
Nov. 710, 711, 712, 713, 714, 715
Dec. 773, 774, 775
Chapters, President Boyden and Vice-President Gurney to Visit, Apr. 274
Characteristics, Non-Dimensional Fan, H. Carlton Moore, Sept. 580
Characteristics of Air Supply Outlets, The Noise, D. J. Stewart and G. F. Drake, Jan. 65
Chicago Exposition of Power and Mechanical Engineering, July. 469
Cleaning Devices, An Alternate Method of Comparing the Dust Arrestance of Air, Arthur Nutting, Aug. 511
Coal Burning Tests on Underfeed Stokers, Sept. 576
Coal Utilization, Institute on, June. 407
Coal Utilization, Short Course in, July. 468
Coals, Bureau of Mines Continues Survey of American, Aug. 528
Coefficients for Walls with Air Space Insulation, Calculated Over-all, F. B. Rowley, July. 444
Coils to Air Washer Systems, The Adaptability of Precooling, John Everetts, Jr., July. 441
Come to Swampscott in June, A.S.V.H.E. Semi-Annual Meeting, May. 338
Committee on Research for 1936, Report of, W. A. Danielson and F. C. Houghten, Feb. 126
Conditioned Air, Fever Therapy Induced by, F. C. Houghten, M. B. Ferderber and Carl Gutberlet, Feb. 115
Conditioned Office, Summer Cooling Requirements of 275 Workers in an Air, A. B. Newton, F. C. Houghten, Carl Gutberlet and R. W. Qualley, Dec. 758
Conditioning by Low Pressure Steam, Summer and Winter Air, G. F. Zellhoefer, Apr. 265
Conditioning Courses, Heating, Ventilating and Air, Oct. 643
Conditioning, Measuring Air Distribution and Grille Performance in Air, G. L. Tuve, Nov. 700
Conditioning System Use, How Much Power Will an Air, Anson D. Marston, Aug. 513

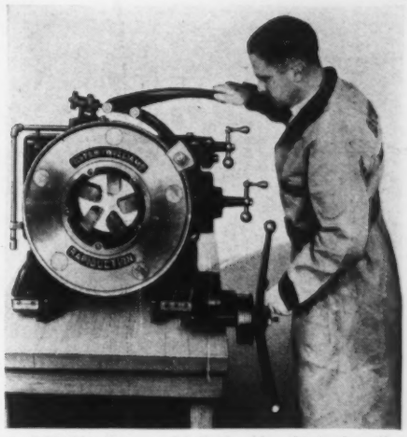
Conditioning to the Treatment of Disease, Application of Air, C. P. Yaglou, Oct. 635
Conditions for the Manufacturing of Confections, Proper Air, A. E. Stacey, Jr., Oct. 640
Confections, Proper Air Conditions for the Manufacturing of, A. E. Stacey, Jr., Oct. 640
Conference at Iowa State, Heating and Air Conditioning, June 407
Congress for Technical Education, International, Apr. 274
Construction, Radiation and Convection Across Air Spaces in Frame, Gordon B. Wilkes and Carl M. F. Peterson, Aug. 505
Control and Types of Registers as Affecting Temperature Variations in the Research Residence, Study of Methods of, A. P. Kratz and S. Konzo, Dec. 745
Control of Body Heat Loss Through Radiant Means, C. A. Mills and Cordelia Ogle, Nov. 697
Convection Across Air Spaces in Frame Construction, Radiation and, Gordon B. Wilkes and Carl M. F. Peterson, Aug. 505
Convectors, The Cooling and Heating Rates of a Room with Different Types of Steam Radiators and, A. P. Kratz, M. K. Fahnestock and E. L. Broderick, Apr. 251
Cooling and Dehumidifying, Performance of Fin-Tube Units for Air, G. L. Tuve and C. A. McKeeman, June. 379
Cooling and Heating Rates of a Room With Different Types of Steam Radiators and Convectors, The, A. P. Kratz, M. K. Fahnestock and E. L. Broderick, Apr. 251
(Cooperative Research Paper)
Cooling in the Research Residence Using Water at Temperatures of 52F and 46F, Study of Summer, A. P. Kratz, S. Konzo and E. L. Broderick.
Part 1, May 319
Part 2, June 391
Cooling Load Analysis of a Bank Building, John James, Sept. 569
Cooling Requirements of 275 Workers in an Air Conditioned Office, Summer, A. B. Newton, F. C. Houghten, Carl Gutberlet and R. W. Qualley, Dec. 758
Correlating Thermal Research, A New Service in, May. 327
Correlating Thermal Research, June. 385
July 460
Aug. 522
Sept. 586
Oct. 652
Nov. 709
Dec. 769
Corrosion Studies in Steam Heating Systems, R. R. Seeber and Margaret R. Holley, June. 387
(Cooperative Research Paper)
Council Gets Carnegie Appropriation, Engineers', Jan. 76
Council Members Elected for Three-year Term, Feb. 140
Council Members Nominated for Three-year Term, Oct. 649
Courses, Heating, Ventilating and Air Conditioning, Oct. 643
Crane Co. Appoints Director of Engineering and Research Division, Dec. 775
Cross, R. C., and R. A. Sherman, Heat Losses and Efficiencies of Fuels in Residential Heating, Jan. 53
Danielson, W. A., and F. C. Houghten, Report of Committee on Research for 1936, Feb. 126
Deaths
Cherven, V. W., Jan. 81
Clarke, S. S., Mar. 210
Coe, R. T., June. 408
Fansler, P. E., Dec. 776
Firestone, James F., July. 469
Flinn, Alfred D., Apr. 277
Gilling, William F., Nov. 715
Good, Macy S., May. 344
Hayward, R. B., Sept. 596
Hood, O. P., June. 408
Howell, Frank B., Nov. 716
Mandeville, E. W., May. 344
Millar, R. J., Jan. 81
Ohmes, Arthur K., Mar. 210
Riley, Champlain L., May. 340
Sakouta, Mathieu L., Mar. 211
Thomson, Elihu, Apr. 277
Vogt, John H., Oct. 656
Wilson, William H., July. 469
Dehumidifying, Performance of Fin-Tube Units for Air Cooling and, G. L. Tuve and C. A. McKeeman, June. 379
Design, A Rational Method of Duct, L. G. Miller, Feb. 121
Devices, An Alternate Method of Comparing the Dust Arrestance of Air Cleaning, Arthur Nutting, Aug. 511
Disease, Application of Air Conditioning to the Treatment of, C. P. Yaglou, Oct. 635
Distribution and Grille Performance in Air Conditioning, Measuring Air, G. L. Tuve, Nov. 700
Domestic Gas Burner Design, Oct. 642
Drake, G. F., and D. J. Stewart, The Noise Characteristics of Air Supply Outlets, Jan. 65
Driscoll, W. H., Joins Carrier Corporation, Mar. 207
Duct Design, A Rational Method of, L. G. Miller, Feb. 121
Dues for 1938, Initiation Fees and, Nov. 705
Dust Arrestance of Air Cleaning Devices, An Alternate Method of Comparing the, Arthur Nutting, Aug. 511
Dust Control Equipment Association Meets, Aug. 528
Education, International Congress for Technical, Apr. 274
Effect, Heating Requirements of an Office Building as Influenced by the Stack, F. C. Houghten and Carl Gutberlet, July 451
Efficiencies of Fuels in Residential Heating, Heat Losses and, R. A. Sherman and R. C. Cross, Jan. 53
Elected for Three-Year Term, Council Members, Feb. 140
Elected in 1937, A.S.H.V.E. Officers, Feb. 139
Elected to Life Membership, Dec. 766
Electrical Engineers Elect Officers, Aug. 530
Elimination, The Nature of Noise in Ventilating Systems and Methods for Its, J. S. Parkinson, Mar. 183
Employment in the Engineering Profession, Aug. 519
Energy Between the Body and Its Environment, Investigations on the Exchanges of, Charles Sheard and M. M. D. Williams, Mar. 189
Engineering Registration Laws, Sept. 579
Engineers' Council Gets Carnegie Appropriation, Jan. 76
Engineers Meet in New York, Refrigerating, Jan. 76
Environment, Investigations on the Exchanges of Energy Between the Body and Its, Charles Sheard and M. M. D. Williams, Mar. 189
Everetts, John, Jr., The Adaptability of Precooling Coils to Air Washer Systems, July. 441
Ewens, F. G., and E. A. Allcut, Heat Insulation Tests and Their Application, May. 328
Exchanges of Energy Between the Body and Its Environment, Investigations on the, Charles Sheard and M. M. D. Williams, Mar. 189
Exhaust System Standards Drafted, Mar. 194
Explosions in Domestic Heating Furnaces May Be Minimized by Proper Firing Methods, July. 457
Exposition, 44th Annual Meeting and 5th, July. 468
Exposition, Advisory Committee Appointed for Fifth, June 407
Exposition, Fifth International Heating and Ventilating, May 335
Fahnestock, M. K., E. L. Broderick and A. P. Kratz, The Cooling and Heating Rates of a Room with Different Types of Steam Radiators and Convectors, Apr. 251
Fan Characteristics, Non-Dimensional, H. Carlton Moore, Sept. 580
Fans, Axial-Flow, Aug. 519
Ferderber, M. B., Carl Gutberlet and F. C. Houghten, Fever Therapy Induced by Conditioned Air, Feb. 115
Fever Therapy Induced by Conditioned Air, F. C. Houghten, M. B. Ferderber and Carl Gutberlet, Feb. 115
(Research Laboratory Paper.)
Fifth International Heating and Ventilating Exposition, May 335
Fin-Tube Units for Air Cooling and Dehumidifying, Performance of, G. L. Tuve and C. A. McKeeman, June. 379
Foil Insulation, Note on the Testing of Aluminum, J. D. Babbitt, Sept. 577
Foundation of America, The Air Hygiene, Jan. 76
Frame Construction, Radiation and Convection Across Air Spaces in, Gordon B. Wilkes and Carl M. F. Peterson, Aug. 505
Fuels in Residential Heating, Heat Losses and Efficiencies of, R. A. Sherman and R. C. Cross, Jan. 53
Furnace Manufacturers Meet in Chicago, Jan. 75
Gas Burner Design, Domestic, Oct. 642
Goddard, R. C., Again Heads Stoker Manufacturers' Association, July 468
Greenleaf Opens Consulting Office in Cleveland, Dec. 776
Grille Performance in Air Conditioning, Measuring Air Distribution and, G. L. Tuve, Nov. 700
Gurney to Visit Chapters, President Boyden and Vice-President, Apr. 274
Gutberlet, Carl, and F. C. Houghten, Heating Requirements of an Office Building as Influenced by the Stack Effect, July 451
Gutberlet, Carl, F. C. Houghten and M. B. Ferderber, Fever Therapy Induced by Conditioned Air, Feb. 115
Gutberlet, Carl, R. W. Qualley, A. B. Newton and F. C. Houghten, Summer Cooling Requirements of 275 Workers in an Air Conditioned Office, Dec. 758
Handbook of Chemistry and Physics, Review of, Aug. 512
Heat Insulation Tests and Their Application, E. A. Allcut and F. G. Ewens, May. 328
Heat Loss Through Radiant Means, Control of Body, C. A. Mills and Cordelia Ogle, Nov. 697
Heat Losses and Efficiencies of Fuels in Residential Heating, R. A. Sherman and R. C. Cross, Jan. 53
Heating and Air Conditioning Conference at Iowa State, June 407
Heating and Ventilating Exposition, Fifth International, May 335
Heating, Heat Losses and Efficiencies of Fuels in Residential, R. A. Sherman and R. C. Cross, Jan. 53
Heating Rates of a Room with Different Types of Steam Radiators and Convectors, The Cooling and, A. P. Kratz, M. K. Fahnestock and E. L. Broderick, Apr. 251
Heating Requirements of an Office Building as Influenced by the Stack Effect, F. C. Houghten and Carl Gutberlet, July 451
(Research Laboratory Paper.)
Heating Systems, Corrosion Studies in Steam, R. R. Seeber and Margaret R. Holley, June. 387
Heating, Ventilating and Air Conditioning Courses, Oct. 643
Hill, Dr. E. Vernon, Associated with Refrigeration and Air Conditioning Institute, May. 344
Holley, Margaret R., and R. R. Seeber, Corrosion Studies in Steam Heating Systems, June. 387
Houghten, F. C., and Carl Gutberlet, Heating Requirements of an Office Building as Influenced by the Stack Effect, July 451
Houghten, F. C., and W. A. Danielson, Report of Committee on Research for 1936, Feb. 126
Houghten, F. C., Carl Gutberlet, R. W. Qualley and A. B. Newton, Summer Cooling Requirements of 275 Workers in an Air Conditioned Office, Dec. 758
Houghten, F. C., M. B. Ferderber and Carl Gutberlet, Fever Therapy Induced by Conditioned Air, Feb. 115
Houghten, Resolution of Appreciation to F. C., Apr. 274
How Much Heat, Nov. 699
How Much Power Will an Air Conditioning System Use, Anson D. Marston, Aug. 513
H. P. & A. C. C. N. A. Meeting, July. 468
Hygiene Foundation of America, The Air, Jan. 76
Initiation Fees and Dues for 1938, Nov. 705
Inspiration of Society Membership, The:
Driscoll, W. H., Apr. 271
Lewis, S. R., May. 335
Jones, W. T., July. 461
Carrier, W. H., Aug. 523
Willard, A. C., Oct. 646
Hart, Harry M., Nov. 703
Rowley, F. B., Dec. 757
Institute on Coal Utilization, June. 407
Insulation, Calculated Over-all Coefficients for Walls with Air Space, F. B. Rowley, July. 444
Insulation, Note on the Testing of Aluminum Foil, J. D. Babbitt, Sept. 577
Insulation Tests and Their Application, Heat, E. A. Allcut and F. G. Ewens, May. 328
International Congress for Technical Education, Apr. 274

Investigations on the Exchanges of Energy Between the Body and Its Environment, Charles Sheard and M. M. D. Williams, Mar. 189
Jacobus, Dr. D. S., Receives Morehead Medal, Jan. 75
James, John, Cooling Load Analysis of a Bank Building, Sept. 569
Japanese Engineering Societies, Carrier Honored by, Jan. 75
Konzo, S., and A. P. Kratz, Study of Methods of Control and Types of Registers as Affecting Temperature Variations in the Research Residence, Dec. 745
Konzo, S., E. L. Broderick and A. P. Kratz, Study of Summer Cooling in the Research Residence Using Water at Temperatures of 52F and 46F,
Part 1, May. 319
Part 2, June. 391
Kratz, A. P., and S. Konzo, Study of Methods of Control and Types of Registers as Affecting Temperature Variations in the Research Residence, Dec. 745
Kratz, A. P., M. K. Fahnestock and E. L. Broderick, The Cooling and Heating Rates of a Room with Different Types of Steam Radiators and Convectors, Apr. 251
Kratz, A. P., S. Konzo and E. L. Broderick, Study of Summer Cooling in the Research Residence Using Water at Temperatures of 52F and 46F,
Part 1, May. 319
Part 2, June. 391
Laws, Engineering Registration, Sept. 579
Life Membership, Elected to, Dec. 766
Load Analysis of a Bank Building, Cooling, John James, Sept. 569
Loss Through Radiant Means, Control of Body Heat, C. A. Mills and Cordelia Ogle, Nov. 697
Losses and Efficiencies of Fuels in Residential Heating, Heat, R. A. Sherman and R. C. Cross, Jan. 53
Low Pressure Steam, Summer and Winter Air Conditioning by, G. F. Zellhoefer, Apr. 265
Manufacturers Meet in Chicago, Furnace, Jan. 75
Manufacturing of Confections, Proper Air Conditions for the, A. E. Stacey, Jr., Oct. 640
Marston, Anson D., How Much Power Will an Air Conditioning System Use, Aug. 513
McKeeman, C. A., and G. L. Tuve, Performance of Fin-Tube Units for Air Cooling and Dehumidifying, June 379
Means, Control of Body Heat Loss Through Radiant, C. A. Mills and Cordelia Ogle, Nov. 697
Measuring Air Distribution and Grille Performance in Air Conditioning, G. L. Tuve, Nov. 700
Medal, Dr. D. S. Jacobus Receives Morehead, Jan. 75
Meeting 1937, Proceedings of the Semi-Annual, Aug. 524
Meeting, Come to Swampscott in June, A.S.H.V.E. Semi-Annual, May 338
Meeting in New York, A.S.H.V.E. Annual, Nov. 704
Meeting—June 24-26, Semi-Annual, Apr. 271
Meeting, New York Prepares for January, Dec. 770
Meeting, New York Will Entertain A.S.H.V.E. at 44th Annual, Oct. 653
Meeting of A.S.H.V.E., 44th Annual, Sept. 589
Meeting, Proceedings of the 43rd Annual, Mar. 198
Meeting, Program, 44th Annual, Dec. 771
Meeting, Program, A.S.H.V.E. Annual, Jan. 74
Meeting, Program, A.S.H.V.E. Semi-Annual, June. 402
Members Elected for Three-Year Term, Council, Feb. 140
Method of Comparing the Dust Arrestance of Air Cleaning Devices, An Alternate, Arthur Nutting, Aug. 511
Method of Duct Design, A Rational, L. G. Miller, Feb. 121
Methods of Control and Types of Registers as Affecting Temperature Variations in the Research Residence, Study of, A. P. Kratz and S. Konzo, Dec. 745
Methods for Its Elimination, The Nature of Noise in Ventilating Systems and, J. S. Parkinson, Mar. 183
Miller, L. G., A Rational Method of Duct Design, Feb. 121
Mills, C. A., and Cordelia Ogle, Control of Body Heat Loss Through Radiant Means, Nov. 697
Moore, H. Carlton, Non-Dimensional Fan Characteristics, Sept. 580
Morehead Medal, Dr. D. S. Jacobus Receives, Jan. 75
Nature of Noise in Ventilating Systems and Methods for Its Elimination, The, J. S. Parkinson, Mar. 183
New Laboratory Dedicated, Nov. 716
New Offices and Factory, Dec. 776
New Service in Correlating Thermal Research, A, May. 327
New York, A.S.H.V.E. Annual Meeting in, Nov. 704
New York Prepares for January Meeting, Dec. 770
New York Will Entertain A.S.H.V.E. at 44th Annual Meeting, Oct. 653
New York World's Fair, Aug. 530
Newton, A. B., F. C. Houghten, Carl Gutberlet and R. W. Qualley, Summer Cooling Requirements of 275 Workers in an Air Conditioned Office, Dec. 758
Noise Characteristics of Air Supply Outlets, The, D. J. Stewart and G. F. Drake, Jan. 65
Noise in Ventilating Systems and Methods for Its Elimination, The Nature of, J. S. Parkinson, Mar. 183
Nominated for Three-Year Term, Council Members, Oct. 649
Nominations for 1937, Jan. 72
Nominations for 1938, Oct. 647
Nov. 706
Dec. 772
Nominees for A.S.H.V.E. Officers in 1938, Oct. 648
Non-Dimensional Fan Characteristics, H. Carlton Moore, Sept. 580
Note on the Testing of Aluminum Foil Insulation, J. D. Babbitt, Sept. 577
Nutting, Arthur, An Alternate Method of Comparing the Dust Arrestance of Air Cleaning Devices, Aug. 511
Office Building as Influenced by the Stack Effect, Heating Requirements of an, F. C. Houghten and Carl Gutberlet, July 451
Office, Summer Cooling Requirements of 275 Workers in an Air Conditioned, A. B. Newton, F. C. Houghten, Carl Gutberlet and R. W. Qualley, Dec. 758
Officers Elected in 1937, A.S.H.V.E., Feb. 139
Officers in 1938, Nominees for A.S.H.V.E., Oct. 648
Ogle, Cordelia and C. A. Mills, Control of Body Heat Loss Through Radiant Means, Nov. 697
Oil Burner Exhibit Announced, Jan. 76
Oil Burner Institute Elects Officers, May. 344
Outlets, The Noise Characteristics of Air Supply, D. J. Stewart and G. F. Drake, Jan. 65
Papers, Reprints of A.S.H.V.E., Sept. 582
Parkinson, J. S., The Nature of Noise in Ventilating Systems and Methods for Its Elimination, Mar. 183
Performance in Air Conditioning, Measuring Air Distribution and Grille, G. L. Tuve, Nov. 700
Performance of Fin-Tube Units for Air Cooling and Dehumidifying, G. L. Tuve and C. A. McKeeman, June. (Cooperative Research Paper.) 379
Peterson, Carl M. F., and Gordon B. Wilkes, Radiation and Convection Across Air Spaces in Frame Construction, Aug. 505
Power Show Held in New York, Jan. 76
Power Will an Air Conditioning System Use, How Much, Anson D. Marston, Aug. 513
Precooling Coils to Air Washer Systems, The Adaptability of, John Everetts, Jr., July. 441
President Boyden and Vice-President Gurney to Visit Chapters, Apr. 274
Pressure Steam, Summer and Winter Air Conditioning by Low, G. F. Zellhoefer, Apr. 265
Proceedings of the 43rd Annual Meeting, Mar. 198
Proceedings of the Semi-Annual Meeting 1937, Aug. 524
Proctor Appointed by G. E., Dec. 776
Program, 44th Annual Meeting, Dec. 771
Program 44th Annual Meeting, Tentative, Nov. 705
Program, A.S.H.V.E. Annual Meeting, Jan. 74
Program, A.S.H.V.E. Semi-Annual Meeting, June. 402
Proper Air Conditions for the Manufacturing of Confections, A. E. Stacey, Jr., Oct. 640
Qualley, R. W., A. B. Newton, F. C. Houghten and Carl Gutberlet, Summer Cooling Requirements of 275 Workers in an Air Conditioned Office, Dec. 758
Radiant Means, Control of Body Heat Loss Through, C. A. Mills and Cordelia Ogle, Nov. 697
Radiation and Convection Across Air Spaces in Frame Construction, Gordon B. Wilkes and Carl M. F. Peterson, Aug. 505
Radiators and Convectors, The Cooling and Heating Rates of a Room with Different Types of Steam, A. P. Kratz, M. K. Fahnestock and E. L. Broderick, Apr. 251
Rates of a Room with Different Types of Steam Radiators and Convectors, The Cooling and Heating, A. P. Kratz, M. K. Fahnestock and E. L. Broderick, Apr. 251
Rational Method of Duct Design, A, L. G. Miller, Feb. 121
Refrigerating Engineers Meet in New York, Jan. 76
Refrigerating Machinery and Air Conditioning Manufacturers to Meet, May. 335
Refrigeration and Air Conditioning Institute, Dr. E. Vernon Hill Associated with, May. 344
Refrigeration Engineering, July. 450
Registers as Affecting Temperature Variations in the Research Residence, Study of Methods of Control and Types of, A. P. Kratz and S. Konzo, Dec. 745
Report of
A.S.H.V.E.-A.S.R.E. Committee on National Standards for Air Conditioning Applications, Mar. 206
Board of Tellers, Mar. 203
Committee on Constitution and By-Laws, Mar. 204
Committee on Research, Mar. 202
Council, Mar. 202
Finance Committee, Mar. 200
Guide Publication Committee, Mar. 204
Membership Committee, Mar. 201
President, Mar. 198
Secretary, Mar. 202
Treasurer, Mar. 199
Report of Committee on Research for 1936, W. A. Danielson and F. C. Houghten, Feb. 126
Reprints of A.S.H.V.E. Papers, Sept. 582
Requirements of 275 Workers in an Air Conditioned Office, Summer Cooling, A. B. Newton, F. C. Houghten, Carl Gutberlet and R. W. Qualley, Dec. 758
Requirements of an Office Building as Influenced by the Stack Effect, Heating, F. C. Houghten and Carl Gutberlet, July 451
Requirements (Part 2) Ventilation, C. P. Yaglou and W. N. Witheridge, July. 447
Research, A New Service in Correlating Thermal, May. 327
Research Chairman Takes New Station, Sept. 591
Research for 1936, Report of Committee on, W. A. Danielson and F. C. Houghten, Feb. 126
Research Goes Into Action, A.S.H.V.E., Mar. 196
Research Residence Using Water at Temperatures of 52F and 46F, Study of Summer Cooling in the, A. P. Kratz, S. Konzo and E. L. Broderick,
Part 1, May. 319
Part 2, June. 391
Residence, Study of Methods of Control and Types of Registers as Affecting Temperature Variations in the Research, A. P. Kratz and S. Konzo, Dec. 745
Residence Using Water at Temperatures of 52F and 46F, Study of Summer Cooling in the Research, A. P. Kratz, S. Konzo and E. L. Broderick,
Part 1, May. 319
Part 2, June 391
Residential Heating, Heat Losses and Efficiencies of Fuels in, R. A. Sherman and R. C. Cross, Jan. 53
Resolution of Appreciation to F. C. Houghten, Apr. 274
Returns to London, Sept. 591
Review of Handbook of Chemistry and Physics, Aug. 512
Room with Different Types of Steam Radiators and Convectors, The Cooling and Heating Rates of a, A. P. Kratz, M. K. Fahnestock and E. L. Broderick, Apr. 251
Rowley, F. B., Calculated Over-all Coefficients for Walls with Air Space Insulation, July. 444
St. Louis Is Ready, Jan. 73
Seeber, R. R., and Margaret R. Holley, Corrosion Studies in Steam Heating Systems, June. 387
Semi-Annual Meeting, 1937, Proceedings of the, Aug. 524
Semi-Annual Meeting. Come to Swampscott in June, A.S.H.V.E., May 338
Semi-Annual Meeting—June 24-26, Apr. 271
Semi-Annual Meeting, Program, A.S.H.V.E., June. 402
Sheard, Charles and M. M. D. Williams, Investigations on the Exchanges of Energy Between the Body and Its Environment, Mar. 189

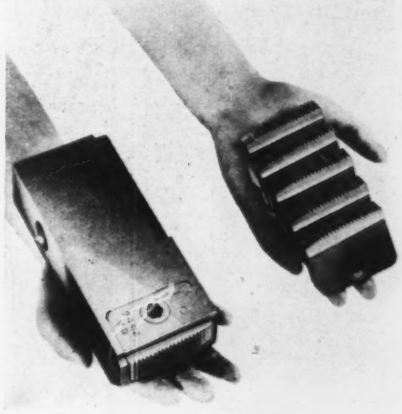
Sherman, R. A., and R. C. Cross, Heat Losses and Efficiencies of Fuels in Residential Heating, Jan. 53
Short Course in Coal Utilization, July 468
Societies, Carrier Honored by Japanese Engineering, Jan. 75
Solid Fuel Meeting Report, Oct. 639
Space Insulation, Calculated Over-all Coefficients for Walls with Air, F. B. Rowley, July 444
Spaces in Frame Construction, Radiation and Convection Across Air, Gordon B. Wilkes and Carl M. F. Peterson, Aug. 505
Speakers Bureau Established for Chapters, Sept. 591
Stacey, Jr., A. E., Proper Air Conditions for the Manufacturing of Confections, Oct. 640
Stack Effect, Heating Requirements of an Office Building as Influenced by the, F. C. Houghten and Carl Gutberlet, July 451
Standards Drafted, Exhaust Systems, Mar. 194
Statistics on Air Conditioning Orders, Jan. 70
Steam Heating Systems, Corrosion Studies in, R. R. Seeber and Margaret R. Holley, June 387
Steam Radiators and Convectors, The Cooling and Heating Rates of a Room with Different Types of, A. P. Kratz, M. K. Fahnestock and E. L. Broderick, Apr. 251
Steam, Summer and Winter Air Conditioning by Low Pressure, G. F. Zellhoefer, Apr. 265
Stewart, D. J., and G. F. Drake, The Noise Characteristics of Air Supply Outlets, Jan. 65
Stoker Manufacturers' Association, R. C. Goddard Again Heads, July 468
Stokers, Coal Burning Tests on Underfeed, Sept. 576
Studies in Steam Heating Systems, Corrosion, R. R. Seeber and Margaret R. Holley, June 387
Study of Methods of Control and Types of Registers as Affecting Temperature Variations in the Research Residence, A. P. Kratz and S. Konzo, Dec. 745
Study of Summer Cooling in the Research Residence Using Water at Temperatures of 52F and 46F, A. P. Kratz, S. Konzo and E. L. Broderick,
Part 1, May 319
Part 2, June 391
(Cooperative Research Paper.)
Summer and Winter Air Conditioning by Low Pressure Steam, G. F. Zellhoefer, Apr. 265
Summer Cooling in the Research Residence Using Water at Temperatures of 52F and 46F, Study of, A. P. Kratz, S. Konzo and E. L. Broderick,
Part 1, May 319
Part 2, June 391
Summer Cooling Requirements of 275 Workers in an Air Conditioned Office, A. B. Newton, F. C. Houghten, Carl Gutberlet and R. W. Qualley, Dec. 758
Swampscott, All Aboard for, June 401
Swampscott in June, A.S.H.V.E. Semi-Annual Meeting, Come to, May 338
Symbols Committee Meets, July 468
Symbols Group Meets, May 340
System Use, How Much Power Will an Air Conditioning, Anson D. Marston, Aug. 513
Systems and Methods for Its Elimination, The Nature of Noise in Ventilating, J. S. Parkinson, Mar. 183
Systems, Corrosion Studies in Steam Heating, R. R. Seeber and Margaret R. Holley, June 387
Systems, The Adaptability of Precooling Coils to Air Washer, John Everetts, Jr., July 441
Technical Education, International Congress for, Apr. 274
Temperature Variations in the Research Residence, Study of Methods of Control and Types of Registers as Affecting, A. P. Kratz and S. Konzo, Dec. 745
Temperatures of 52F and 46F, Study of Summer Cooling in the Research Residence Using Water at, A. P. Kratz, S. Konzo and E. L. Broderick,
Part 1, May 319
Part 2, June 391
Tentative Program 44th Annual Meeting, Nov. 705
Terminology, A.S.A. Announces Standard Acoustical, Feb. 120
Testing Exhaust Systems, Jan. 64
Testing of Aluminum Foil Insulation, Note on the, J. D. Babbitt, Sept. 577
Tests and Their Application, Heat Insulation, E. A. Allcut and F. G. Ewens, May 328
Therapy Induced by Conditioned Air, Fever, F. C. Houghten, M. B. Ferderber and Carl Gutberlet, Feb. 115
Thermal Research, A New Service in Correlating, May 327
Transactions Ready for Distribution, Sept. 581
Treatment of Disease, Application of Air Conditioning to the, C. P. Yaglou, Oct. 635
Tuve, G. L., and C. A. McKeeman, Performance of Fin-Tube Units for Air Cooling and Dehumidifying, June 379
Tuve, G. L., Measuring Air Distribution and Grille Performance in Air Conditioning, Nov. 700
Types of Registers as Affecting Temperature Variations in the Research Residence, Study of Methods of Control and, A. P. Kratz and S. Konzo, Dec. 745
Units for Air Cooling and Dehumidifying, Performance of Fin-Tube, G. L. Tuve and C. A. McKeeman, June. 379
Use, How Much Power Will an Air Conditioning System, Anson D. Marston, Aug. 513
Ventilating and Air Conditioning Courses, Heating, Oct. 643
Ventilating Exposition, Fifth International Heating and, May 335
Ventilating Systems and Methods for Its Elimination, The Nature of Noise in, J. S. Parkinson, Mar. 183
Ventilation Requirements (Part 2), C. P. Yaglou and W. N. Witheridge, July 447
(Cooperative Research Paper.)
Vice-President Gurney to Visit Chapters, President Boyden and, Apr. 274
Walls with Air Space Insulation, Calculated Over-all Coefficients for, F. B. Rowley, July 444
Washer Systems, The Adaptability of Precooling Coils to Air, John Everetts, Jr., July 441
Water at Temperatures of 52F and 46F, Study of Summer Cooling in the Research Residence Using, A. P. Kratz, S. Konzo and E. L. Broderick,
Part 1, May 319
Part 2, June 391
Wilkes, Gordon B., and Carl M. F. Peterson, Radiation and Convection Across Air Spaces in Frame Construction, Aug. 505
Williams, M. M. D., and Charles Sheard, Investigations on the Exchanges of Energy Between the Body and Its Environment, Mar. 189
Winter Air Conditioning by Low Pressure Steam, Summer and, G. F. Zellhoefer, Apr. 265
Witheridge, W. N., and C. P. Yaglou, Ventilation Requirements (Part 2), July 447
Workers in an Air Conditioned Office, Summer Cooling Requirements of 275, A. B. Newton, F. C. Houghten, Carl Gutberlet and R. W. Qualley, Dec. 758
World's Fair Administration Building Completed, Sept. 596
Yaglou, C. P., and W. N. Witheridge, Ventilation Requirements (Part 2), July 447
Yaglou, C. P., Application of Air Conditioning to the Treatment of Disease, Oct. 635
Zellhoefer, G. F., Summer and Winter Air Conditioning by Low Pressure Steam, Apr. 265

"No Job Can Balk a Rapiduction"

We didn't write the headline above . . . it was written for us in the comments of Rapiduction owners. Special jobs go through this versatile machine almost exactly as easily as standard jobs. In addition, because of dual clutch control and rear gripping chuck, with powerful step jaws, it saves many a dollar in making up fittings and flanges. For high production, precision threading, choose a RAPIDUCTION. Descriptive folder on request.



(ABOVE) Patented die-head which handles all sizes of pipe within range of each machine without change of dies except when change of pitch is required. (BELOW) Small dies held by massive die-holders which keep chaser-cost to a minimum.



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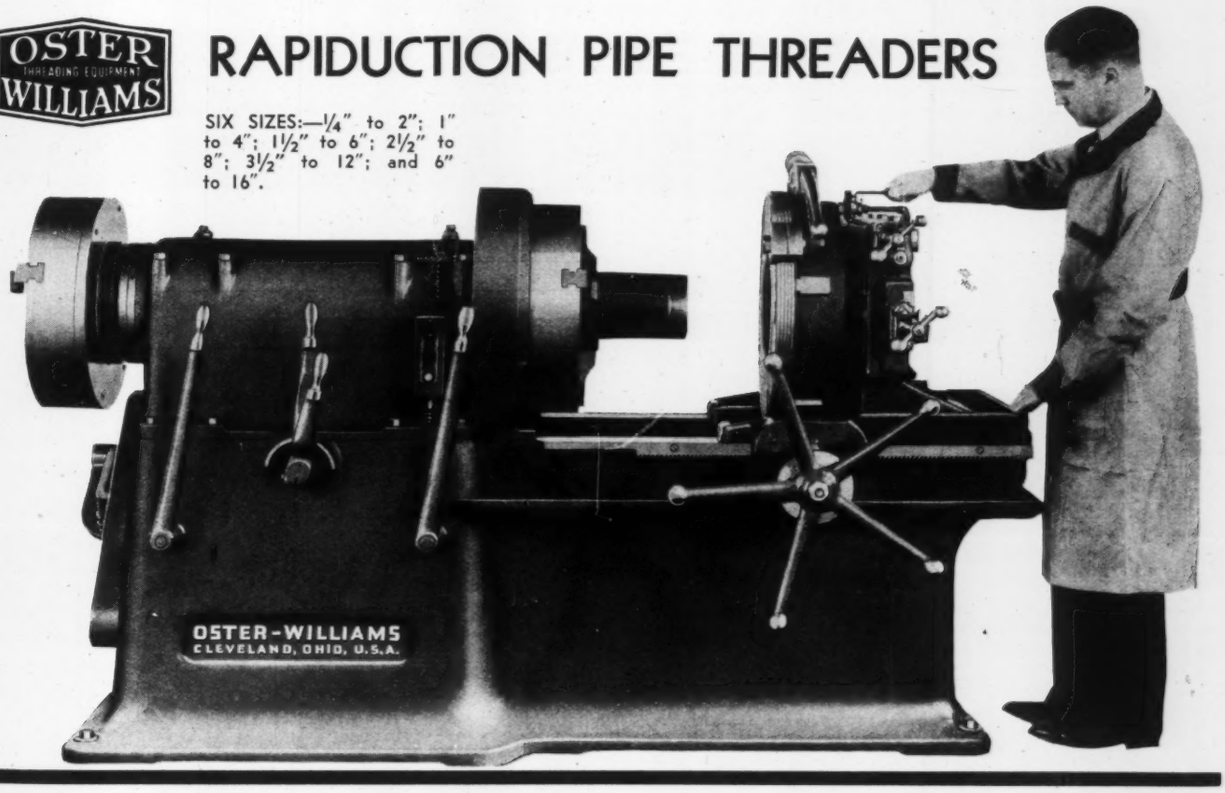
SIX SIZES:—1/4" to 2"; 1" to 4"; 1 1/2" to 6"; 2 1/2" to 8"; 3 1/2" to 12"; and 6" to 16".



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LONDON, ENGLAND - 43 G.T. MARLBOROUGH ST.
September 24, 1937
Vilter Mfg. Co.
114 W. 10th St.
Kansas City, Mo.
Gentlemen:
We thank you for the job you have just completed here. In checking our records of sales for the month of August as compared to last year, we found that we have more than tripled our business and as we can find no other reason, we give you full credit for the increase.
We have also checked our work-room expenses and production and find that our girls are turning out nearly double the amount of work due to the work-room being cooled and the cleaning bills we have had in the past due to the heat in our work-room has been entirely eliminated.
We hope you may do as good a job for many other people in this line of business.
Very truly yours,
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VILTER Equipment AT WORK

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WORK DOUBLED . . .
for *Suzanne,* Inc.

In Specialty Stores, Department Stores, Offices, Hotels, Restaurants, Factories, — in all types of business, Vilter Air Conditioning is paying for itself by dependable day-after-day, year-after-year efficiency and economy in indoor "Weather Control."

Vilter has long been the "Quality" symbol of the fast growing Air Conditioning and Refrigeration Industry. A seventy-year-old reputation for outstanding achievements in industrial refrigeration, a long lifetime spent in developing today's thorough knowledge of Refrigeration and Air Conditioning, — all is combined to give you new and modern efficiency in "Comfort Cooling" Air Conditioning and Refrigeration that only Vilter Engineers can give you.

You'll Profit by calling on Vilter for modern Air Conditioning and Refrigeration.

1- Interior view of the famous St. Louis store of Suzanne, Inc.
2- Vilter Equipment used — one 5¾ x 4½, one 8¼ x 6½ "Freon 12" Compressor.
3- Galleria Building, St. Louis. Completely Air-Conditioned through Heat and Cold, Inc., St. Louis.
4- Attractive Lobby of Galleria Building.

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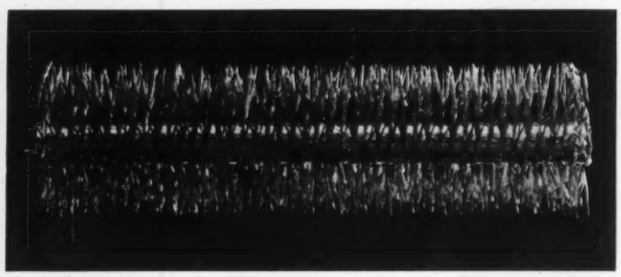
Milwaukee - Wisconsin

Equipment Developments

For your convenience in obtaining more information about any of this equipment, see coupon on page 142. Add the new products and companies listed here to your Directory Section which you received in your January, 1937, HEATING, PIPING AND AIR CONDITIONING and thus keep your records of sources of supply up to date throughout the year . . . Single asterisk (*) indicates equipment not listed in Directory Section; double asterisk (**) equipment and manufacturer not listed

Unique Development in Heat Transfer Surface for Air Conditioning, Refrigeration

No. 1355**—A unique development in the construction of heat transfer surface for use in air conditioning and refrigeration has just been publicly announced. It is a "spine" or "porcupine" design which gives a multiplicity of heat entering edges. The spines are formed by raising sliver-like portions perpendicularly from the tubing itself, a heavy wall tube being the start of the



process. Thus there is no problem of bond between the primary and secondary heat transfer surface, as the secondary surface spines are actually formed from the primary area. The resulting tube looks very much like a rope of the tinsel used to decorate Christmas trees.

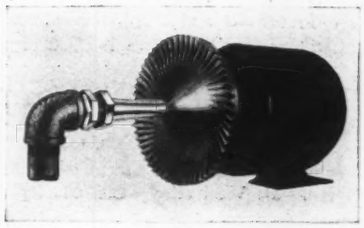
The method of manufacture of the new surface allows a wide variation in the number of spines per square inch of tube surface, height of spines, and cross-sectional area of the spines so that surface for a wide range of ratings can be fabricated. The surface can be of steel, copper, aluminum or any material capable of being machined.

According to the manufacturer, the new feature is a logical step from the rifling feature previously developed. Realizing that the greatest amount of heat transfer in a refrigerant cooling unit took place at the refrigerant wetted internal surfaces of the tubing, rifling was adopted to give a spiral motion to the refrigerant in order to carry it entirely around the inner surface of the tubing and wet the surface 100 per cent. This increased the "internal efficiency," so studies were begun to increase the heat transfer from the air to the outer surface of the cooling unit.

Tests conducted by the manufacturer on a finned coil and the same coil with the fins shredded indicated that when each fin was slot-milled so that it was cut into 36 projections, the slotted coil had a 51 per cent greater heat absorbing capacity although 40 per cent of the fin metal had been removed. From these tests, the spine-like form of construction was developed as the simplest way of manufacturing a surface with the maximum number of heat entering edges.—Peerless of America, 515 W. 35th St., Chicago, Ill.

Humidifying Spray Wheel Announced

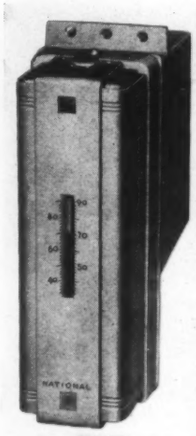
No. 1356**—Improved "Murray-Preston" rotary spray wheel, made of metals or alloys to meet chemical or corrosion conditions, is totally machined. Delivery is through the nozzle, and the spray wheel cannot become clogged no matter what form of contamination, dust, and lint there may be contained in the air, according to the maker.



Readily adaptable to air washers or other equipment having banks of spray nozzles. Low pressure requirements, together with its large space coverage, make for low operating cost. Motor in the case of the direct connected units, is splash-proof, totally enclosed type.—D. J. Murray Mfg. Co., Wausau, Wis.

Submaster Thermostat Newly Designed

No. 1357—Newly designed pneumatic submaster room thermostat regulates temperatures in a room with relationship to conditions at another point. In the summer, for example, it is advisable to raise indoor temperatures as the outside temperatures mount. By installing a submaster thermostat under the regulation of a master controller placed at an outside location, the inside temperature will be raised, say, from 72 to 82 F as the outdoor temperature rises from 70 to 100 F.



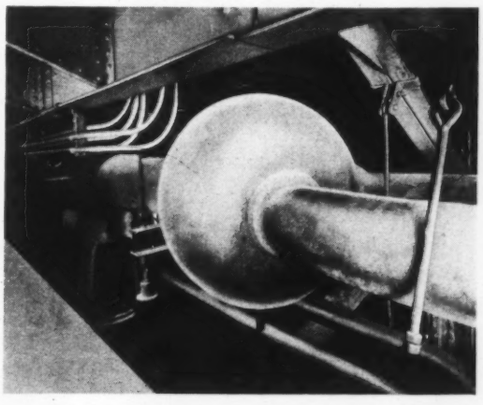
Simplified in design and improved in appearance, the new instrument has been reduced to half its former size. All moving parts operate in a sealed chamber which guarantees its trouble-free, dependable operation over an indefinite period, free from the contamination of dirt, chemicals, chalk dust or any foreign substance, according to the maker. This "Helmet-Seal" protection prevents tampering even to the extent of preventing the disturbing of the operating mechanism by pushing a pencil or any other foreign object through the openings in the case.

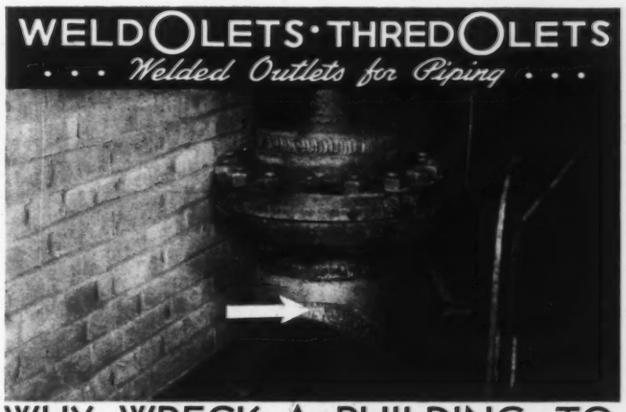
The thermostat is designed for use with all types of heating and cooling equipment where graduated control by compressed air is desired.—Minneapolis-Honeywell Regulator Co., 2701 Fourth Ave., S., Minneapolis, Minn.

Steam Header Is Spherical

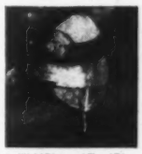
No. 1358—An example of lighter but stronger steam plant equipment is the large steam header which was recently installed in a public utility plant, where it is receiving steam from two 500,000 lb per hr boilers, at 925 F maximum temperature and 1250 lb pressure.

Built in the form of a perfect sphere, of carbon ½ per cent molybdenum forged steel 2 3/8 in. thick, the header, which is 48 in. O.D., receives steam from the boilers through two 12 in. leads and delivers it to the turbine throttle valve through one



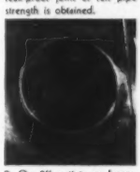


WHY WRECK A BUILDING TO MAKE A PIPE CONNECTION?

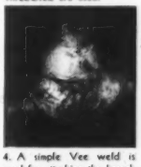


1. WeldOlets and ThredOlets are easily installed. Simply select the position of the outlet, mark center lines and tack the fitting into position.

2. Then weld by oxy-acetylene or electric-arc method. A leak-proof joint of full pipe strength is obtained.



3. On 2" outlets or larger, the button is removed after installation. A full inspection of the inside of the joint is possible when WheldOlets or ThredOlets are used.



4. A simple Vee weld is used for attaching the branch when WeldOlets are used. If ThredOlets are used, the branch is screwed into position.

SOUNDS silly, doesn't it? Yet if anything but a WeldOlet had been used in making the branch pipe take-off shown above, it would have been necessary to tear a hole in the wall of the building.

Instead, the 12" main pipe remained in position. No cutting - no threading - no fitting of the main or branch pipe was necessary. No templets were used. The position of the outlet was selected and the WeldOlet welded into place. The hole was cut in the main pipe after the WeldOlet was installed. An absolutely leak-proof joint was obtained.

Not every job possesses the economy possibilities of this one - but Bonney WeldOlets and ThredOlets cost no more to buy and less to install than any other type of pipe fitting. They're available for all standard pipe sizes and for every piping requirement. For full information sign and mail the coupon below.

The names "WeldOlet" and "Thred-Olet" are Bonney trade marks registered in the United States Patent Office. Full Patent coverage for designs, principles and construction has been granted in the United States and foreign countries.

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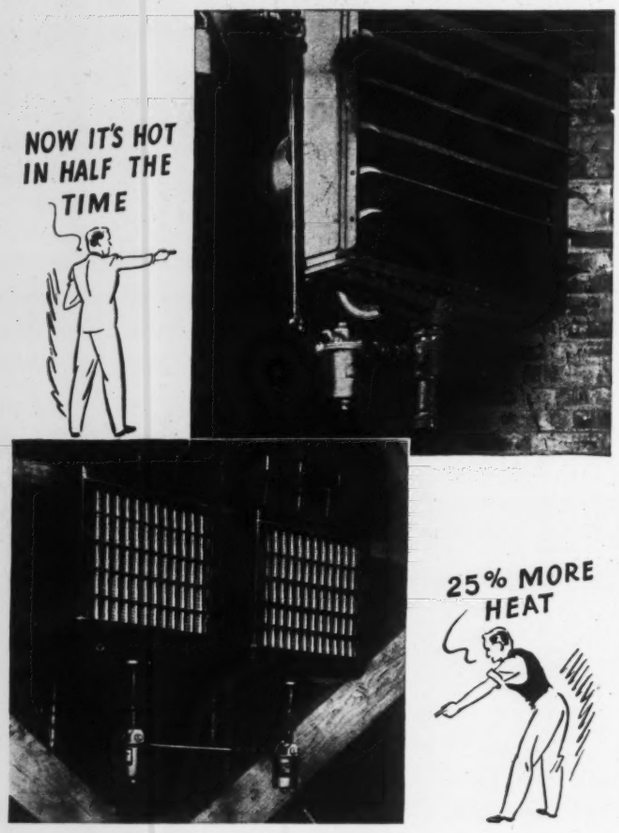
How to get More Heat *and* Instant Heat



TO get more heat from your heating system you must have a steam trap that keeps the system dry at all times. To get instant heat you must have instantaneous removal of entrained air.

Both of these important functions are performed to perfection by Anderson Super-Silvertop steam traps. In a recent test, changing to an Anderson Super-Silvertop trap with Thermal Air Eliminator increased heat output 25%. In another test a unit heater became hot in half the time when a Super-Silvertop trap was used.

Know more about this modern, engineered steam trap—it can save you heating dollars and cut down the heating-up period. Find out now what this extra value trap can do for you. Send for complete information about Anderson Super-Silvertop, the only complete steam trap.

THE V. D. ANDERSON CO.
1949 WEST 96TH STREET • CLEVELAND, OHIO

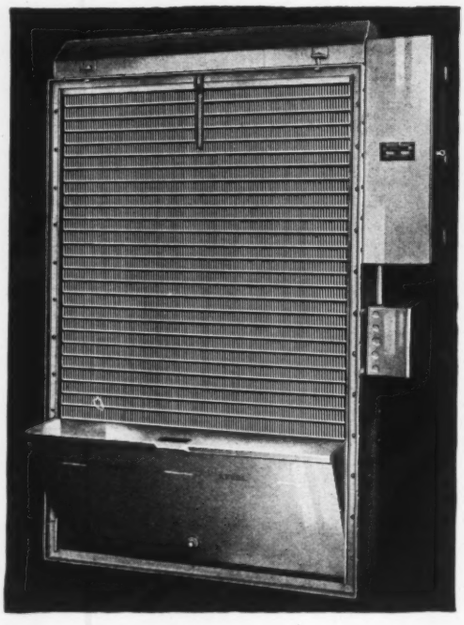
20 in. connection. In its fabrication two perfect hemispheres were first built and then were welded together in accordance with the terms of paragraph U-68 of the A. S. M. E. code for unfired pressure vessels.

It is claimed that this design of spherical steam header effects an appreciable saving in both weight and space over steam headers of the regular design, that it operates with uniform high efficiency and furnishes steam of a uniform temperature to the turbine.—M. W. Kellogg Co., 225 Broadway, New York, N. Y.

Develops Panel Construction for Air Filters

No. 1359—New panel construction developed for the "Multi-Panel" filter is claimed to provide, for the first time, three stages of air cleaning in a curtain type filter, to be non-clogging with lint and heavy granular dust concentrations, to have the same high cleaning efficiency of the former all-screen panel, and to be more positive in its self-cleaning action.

This new "armored" panel is a combination of woven screen and a die-stamped louver section, the latter consisting of closely



spaced vertical streamline-shaped baffles and forming the lower or exposed area of the panel. The upper part of the woven screen section which is at the back of the filter curtain is bakelite-fiber coated to obtain high efficiency in the removal of fine dust particles from the air. The lower part of the screen section which lies immediately behind the "armored" section of the preceding panel is left uncoated to provide a second or intermediate stage of air cleaning.

Lint and coarse granular dust are collected on the "armored" section of the filter curtain. The baffles have ample storage surface to handle a large quantity of bulky material without restricting the air flow, and being vertical permit this accumulation to be readily removed in the oil bath, according to the maker.

The added weight of the "armored" section improves the self-cleaning action by accelerating the movement of the panel through the oil bath. This actively forces the oil through screen section of the panel to obtain more positive removal of the dust accumulation.

The "armored" panel is now standard equipment on all the maker's "Multi-Panel" filters, and is also interchangeable with former types of all-screen panels.—American Air Filter Co., Inc., 107 Central Ave., Louisville, Ky.

Hank

Is Still

Shooting Hot Air About

This Hot Air Shooter

(Others call it a Unit Heater)

More than once in a while, a time comes when I have to give the Boss a talking to. He generally gets the best of it. But he gets my talk too, and we both feel better.

Here yesterday I blew up about the rating table on this Unit Heater of ours. My kick was, it looked like a bunch of new deal nick-names with all its C.F.M.—R.P.M.—H.P.M. and B.T.U.

He said, no one expected me to understand tables, or much of anything else for that matter. But that you'd know what those alphabet things meant, and that was enuff. So I went out and slammed the door. Well, didn't he slam me?

What I wanted to know, wuz how little and how big these heat shooters of ours are and what they would do. After studying a while, the tables started in looking intelligent, and found there wuz 15 sizes. That the Btu started in at 21000 and galloped up to 255500. Then I dug out, that figured in sq. ft. of direct radiation it meant 88 up to 1065. And that's about all I know to date. So if you want more yet particulars, best you send for the catalog.

Hank Hindle

See our Display in Booths 233 and 234 at the Heating & Ventilating Show, Grand Central Palace, New York City, January 24th to 28th inclusive.

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- More business
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Carbondale air conditioning equipment has new and valuable capacity control features. A Carbondale engineer, backed by an organization with 37 years of experience in this field, will be glad to explain them to you . . . and to cooperate fully in the solution of your air conditioning problems. There is no obligation.

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THE development of an *efficient* underground steam conduit is a complex engineering problem, and cannot be accomplished overnight. Unless the BUGS are all out of any such system—it will be a disappointment. With Ric-wiL, the bugs are banished. Such questions as insulation efficiency, tight joints, water-proofing, drainage, alignment, expansion, and ease of installation are *permanently* answered. That's why more and more engineers and owners who know what it's all about are turning to Ric-wiL, with unique Dry-paC Asbestos Insulation, as the *one* satisfactory method of economical underground steam conveyance. It will pay *you* to get the FACTS!

Prevent leakage and loss in your steam lines, keep them tight, dry and 90%+ efficient with a Ric-wiL Tile or Cast Iron System. Ric-wiL service is complete from design to installation and tests, and is nation-wide. On any subsoil steam conveyance problem—under-supply, fuel waste, loss in transit—Ric-wiL can give you effective assistance. Write for complete catalog and test data.

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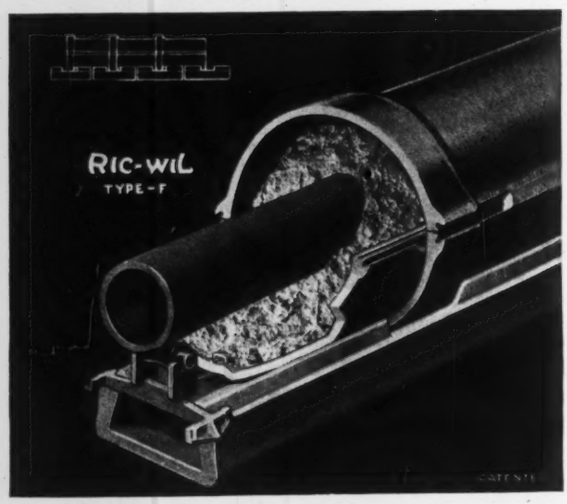

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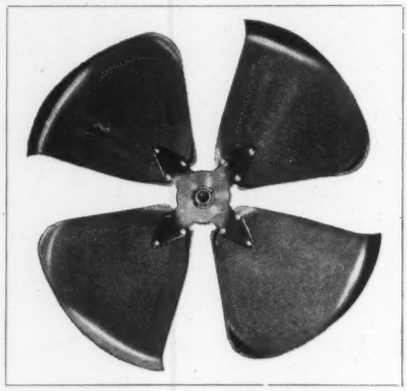
RIC-WIL

CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES

Announces New Propeller Fan

No. 1360*—Under the direction of William Rowe, leading fan engineer, a new propeller fan constructed for quiet operation and high efficiency has been perfected.



These fans are built with four curved steel blades of large area set at an angle of 30 deg with the plane of rotation. The curvature of the blades is so formed to insure the leading edges entering the air stream without shock, says the maker. Wide tips provide for the gradual acceleration of the air particle, essential for quiet operation.

They are being incorporated in unit heaters, unit coolers, evaporative condensers, and other apparatus requiring relatively large volumes of air at moderate pressures.—Trane Co., La Crosse, Wis.

Fibrous Glass Filler Insulation for Underground Piping

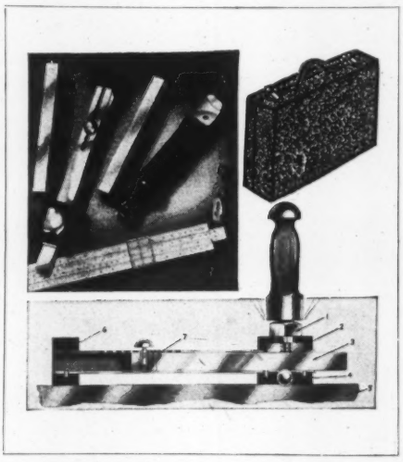
No. 1361—A new application for fibrous glass is the insulation of underground steam lines. Known as "Adsco-Corning" filler insulation, it is composed of long, flexible fibers of true glass in a soft resilient mass resembling cotton batting but possessing the permanence and chemical characteristics of glass.

Tests have shown a low conductivity rate of 0.33 at 4 lb density. It fluffs under vibration instead of packing, settling or disintegrating under such conditions, says the maker. It is fireproof and unaffected by water, acids or fumes, and is light in weight.

It is packed in strong paper bags at a density which is suitable for pipe lines operating at a mean temperature of 650 F, or it can be supplied for higher temperatures.—American District Steam Co., North Tonawanda, N. Y.

Portable Brinell Tests Metal Hardness

No. 1362—A light weight, portable Brinell instrument simplifies metal hardness tests in the field and around industrial plants. According to the manufacturer it can be used in close quarters and can be applied to parts and equipment the size of which have, heretofore, made testing difficult, expensive and sometimes virtually impossible.



It eliminates both the necessity of dismantling equipment to be tested and transporting specimens to the laboratory.

Known as the "Telebrineller," the instrument was developed to check and control the rebuilding (welding) and heat treating of rail ends on the right-of-way. In addition to its more obvious uses in

LET'S STOP THESE "Hold-ups"

Every year, corrosion — the greatest racketeer in the world — robs this country of millions of dollars. Fortunately for pipe users, a large portion of this money can be saved — by using Fretz-Moon Copper-Bearing Steel Pipe. • When you are confronted with alternate wet and dry conditions — atmospheric corrosion — and steel pipe doesn't last as long as you or the customer would like, tell him about this rust-resisting pipe made of high quality steel with which is alloyed the correct amount of copper to obtain maximum corrosion-resistance. It provides the high strength of steel *plus* the exceptional uniformity of product — size, ductility and cleanliness — made possible by the patented "continuous process" employed in manufacture. And the additional cost will be returned many times over through the longer life it affords. • Ask your jobber for Fretz-Moon Copper-Bearing Pipe, black or galvanized. If he doesn't stock it, write us.

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No wonder RIGID has millions of users all over the world. Replaceable jaws are slip-and-lock-proof. Handy pipe scale on full-floating hook jaw. Adjusting nut spins easily in all sizes, 6" to 60". Comfortable grip handle. End pattern for pipes against flat surfaces.

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RIGID PIPE TOOLS

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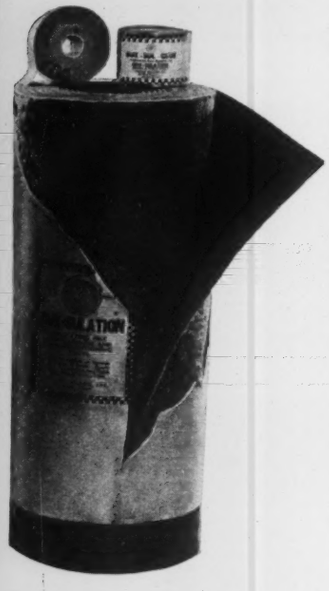

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Dux-Sulation comes to you complete . . . ready for installation . . . as one unit . . . with nothing else to buy. Each package consists of one roll of Asbestos Protected Dux-Sulation Felt, 36 inches wide containing 100 square feet. One roll of Asbestos Protected Dux-Sul-Tape to finish corners and joints, and enough Dux-Sul-Glue to complete the application. It is flexible . . . durable . . . has high insulating and sound absorbing qualities . . . and the entire job is Asbestos Protected.

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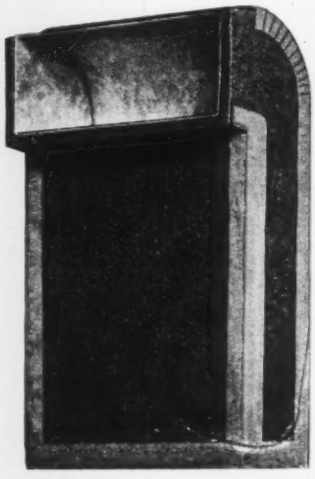
Dux-Sulation is extremely simple to apply. The only things necessary to complete its perfect application is a knife and a paint brush. It is easy to handle as the complete roll can be conveniently carried to any place on the job. You don't have to fool with lugs, bolts, screws, or wire. It does not have to be soaked or scored, and no plastic cements are needed. Asbestos Protected Dux-Sulation is the most economical insulation to use, for every square inch can be used with perfect results.



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Experience for yourself, as have scores of leading contractors, the many savings you can make with Dux-Sulation . . . Put Dux-Sulation on your next job.

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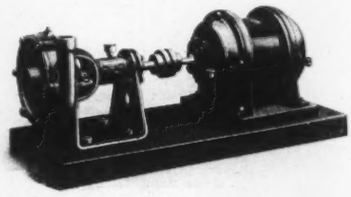
many types of plants throughout the metallurgic industries where it is used both in receiving rooms to check deliveries of raw materials with specifications ordered and in routine production control it also has a number of uses in plant maintenance work. It can be used where knowledge of metal hardness is a factor in safety and continuous operation. A number of oil refineries are said to be employing it to test parent metal adjacent to welded joints in alloy steel pipe in high pressure and hot oil lines which welding and vibration in use are claimed to harden beyond the safety point, heat exchangers, castings and other equipment. Tests made at the time of installation and periodically afterward disclose weak points which are annealed in place. This reduces losses and fire hazard, saves time and eliminates tearing out lines and transporting them long distances for tests.

The outfit is composed of the instrument proper, a bar of known hardness, a microscope with a scale etched in its focal plane and a slide rule, packed with extra test bars and impression balls in a small case. To make a test the instrument is held against the specimen and the anvil is struck a sharp blow with a 3 to 5 lb hammer. The impact is transmitted through the anvil to the bar, then to the ball and on to the specimen. Force of the blow is said not to be a factor, the diameter of the impression in the bar and in the specimen being, in any case, relative to their individual Brinell hardness number. The diameters of the impressions are then measured in 1/10 millimeters by placing the microscope over each in turn and reading the scale. Figuring the Brinell number is then a simple matter using either an arithmetical formula or the slide rule.—Teleweld, Inc., Railway Exchange Bldg., Chicago, Ill.

New Pressed Steel Frame Mounted Pumps

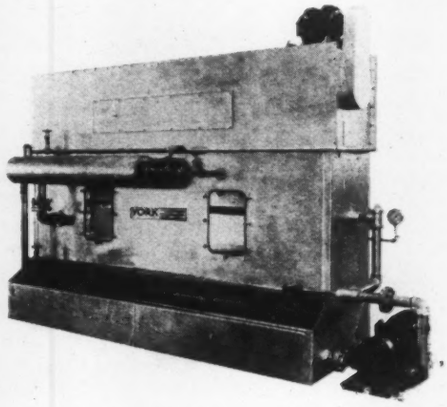
No. 1363—New pressed steel frame mounted ball bearing centrifugal pumps are available for belt or motor drive and are suitable for handling capacities from 10 to 300 gpm at heads from 10 to 120 ft.

The pumps are equipped with two grease lubricated ball bearings. — Worthington Pump and Machinery Corp., Harrison, N. J.



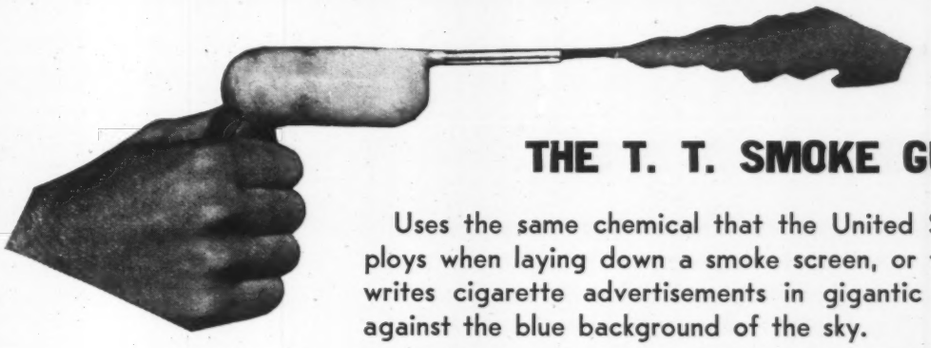
Adds Industrial Air Conditioner

No. 1364—New "FS-12000" spray type air conditioner for industrial applications of low temperature air conditioning is designed to handle air volumes up to 16,000 cfm and capacities



up to 40 tons of refrigeration. Front, back, or top discharge outlets can be provided and spray water heaters and air reheat coils are available for various installation requirements.

A NEW INSTRUMENT OF EXCEPTIONAL MERIT



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EXCLUSIVE CURTIS "CENTRO-RING" POSITIVE PRESSURE LUBRICATION PROVIDES REAL PROTECTION

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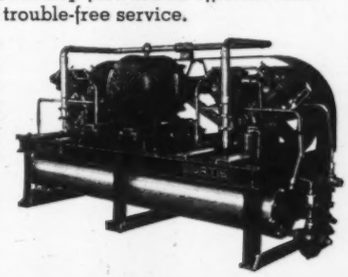
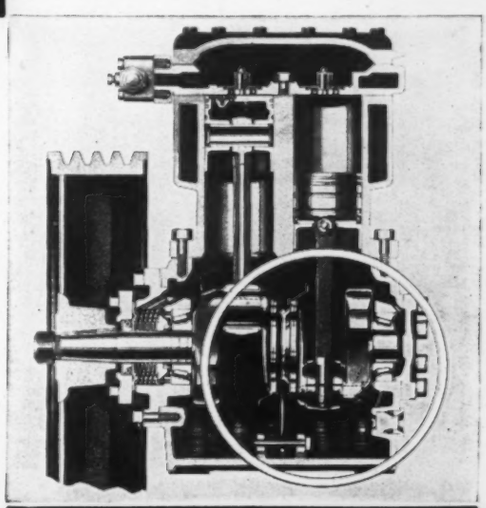
"Centro-Ring" positive pressure lubrication has been recognized throughout the industry as a real step forward in efficient lubrication, assuring long life and trouble-free service.

Engineering originality of this kind has been responsible for the wide use and acceptance of Curtis compressors and condensing units — for their low cost of upkeep and economical performance.

Write us for full details or call your local Curtis representative.





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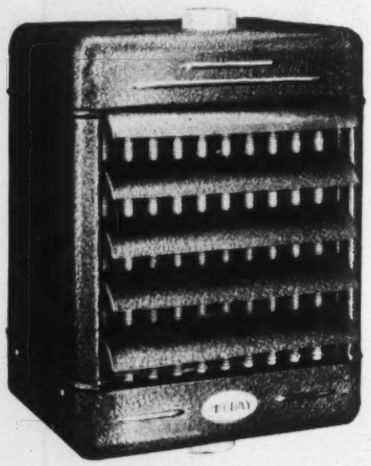
The unit supplements the standard line of the maker's spray type air conditioners which are adaptable for applications requiring constant temperature and relative humidity, such as storages, fruit cooling, textile and printing plants, bakeries, fermentation rooms, and a wide range of similar industrial air conditioning installations.—York Ice Machinery Corp., Roosevelt Ave., York, Pa.

Unit Heaters Have All Copper Element

No. 1365—Illustrated is one of an improved line of unit heaters for commercial and industrial applications. It has an all copper heating element which consists of a series of tubes to which are attached specially designed fins with spun collars, giving a maximum of transfer surface in contact with the tube. Contact between the tube and fin is accomplished by hydraulically expanding the tube into the fin collar to make a permanent bond without the use of solder.



All tubes are orificed to permit equal distribution of steam throughout the element, and the steam carrying passages are cylindrical in shape. The tube and fin assembly is welded into drawn seamless copper tube headers. The entire element is encased in the cabinet with rounded corners and scientifically designed deflecting louvers. The heating element is cradled in the cabinet without the use of bolts or screws to permit it to expand and to contract. The complete cabinet is welded into one integral unit.

Fan and motor are attached to a flexible mounting to reduce vibration to a minimum.—McQuay, Inc., 1600 Broadway, N. E., Minneapolis, Minn.

Electrode for Small A-C Transformer Welders

No. 1366—A new mild steel arc welding electrode, designed particularly for use with small alternating current transformer type arc welders which is said to simplify welding with this type of equipment and provide weld metal of high quality, has been announced. Designated "Transweld," it is the result of extensive research to develop a rod which would meet the special requirements of small a-c transformer welders.

Weld metal produced by the electrode possesses high physical properties, according to the maker. Tensile strength is 75,000 to 85,000 lb per sq in., yield point 60,000 to 68,000 lb, and ductility 20 to 30 per cent elongation in 2 in.—Lincoln Electric Co., 12818 Coit Rd., Cleveland, Ohio.

Overdrive Belt Tightening Motor Offered

No. 1367—A new line of streamlined motors is offered in rigid-resilient and under and overdrive belt tightening styles in the standard fractional sizes and speeds and for two speed drives. They have rounded flowing lines and may be had in split phase, capacitor, and polyphase ratings.

HUSSEY COPPER

For All Types of Air Conditioning Equipment

Modern air-conditioning installations demand the highest quality copper. That is why so many manufacturers prefer HUSSEY COPPER,—a standard quality specification in every industry for more than 89 years.

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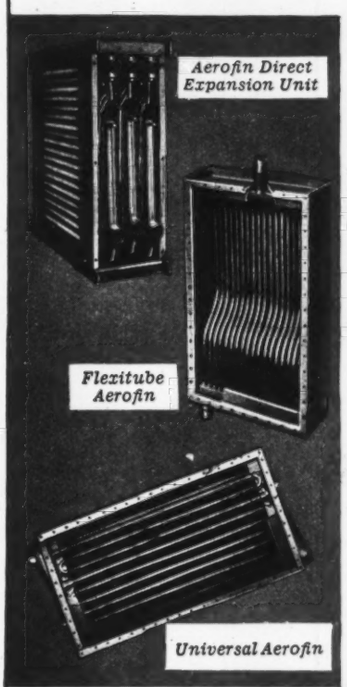
Heat-Exchange Surface



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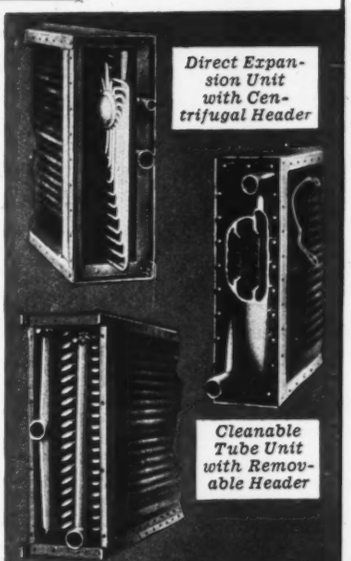
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A thorough treatment of principles and practice . . .

HEATING, VENTILATING and AIR CONDITIONING FUNDAMENTALS

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Professor of Mechanical Engineering
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This book discusses the latest developments in the field, in not too technical language. Essentially practical in nature, it offers the busy engineer a ready means of reviewing basic principles as well as a detailed discussion of present-day methods of handling heating, ventilating and air conditioning problems.

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- Refrigeration apparatus

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WELL IT'S TOO COLD FOR ME BRRR.— I DONT GET ANY HEAT OVER HERE AT ALL
THE CAUSE
UNEVEN DISTRIBUTION OF HEAT BY RADIATORS OR ORDINARY UNIT HEATERS.
THEY GIVE HOT SPOTS AND COLD SPOTS BESIDES WASTING YOUR VALUABLE HEAT IN THE UPPER SPACES.
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WING featherweight
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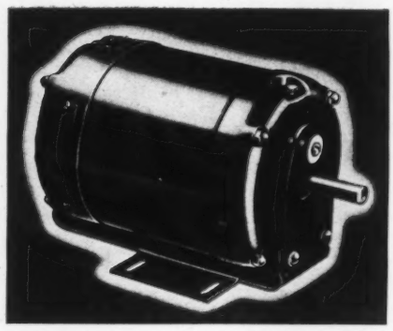


The cut illustrates one type of these new motors of special interest in connection with blowers since blowers usually require an overrunning belt, according to the maker. This motor operates automatically to tighten such belts and thus save service calls.—Ohio Electric Mfg. Co., 5906 Maurice Ave., Cleveland, Ohio.

Blow-off Valves Have Protecting Lip

No. 1368—New boiler blow-off valves incorporate a number of features including the "Blo-Deflector" lip to deflect boiler blow. To further increase their wear resistance the valves have stainless steel valve discs hardened to 500 Brinell and renewable valve seat rings heavily Stellited.

The illustration shows the "Blo-Deflector" protecting lip on the stainless steel valve disc. In the background is a 2 in. straightway type.

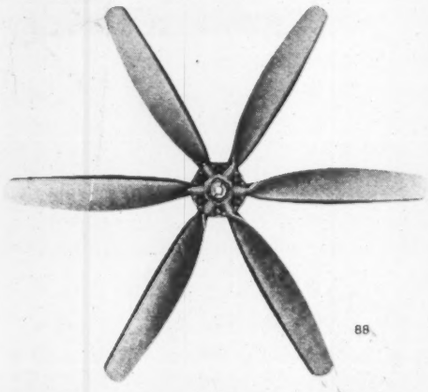
The valves are made in both straightway and angle types for boiler and economizer pressures up to 1660 lb in compliance with A. S. M. E. code requirements.—Hancock Valve Div., Manning, Maxwell & Moore, Inc., Bridgeport, Conn.

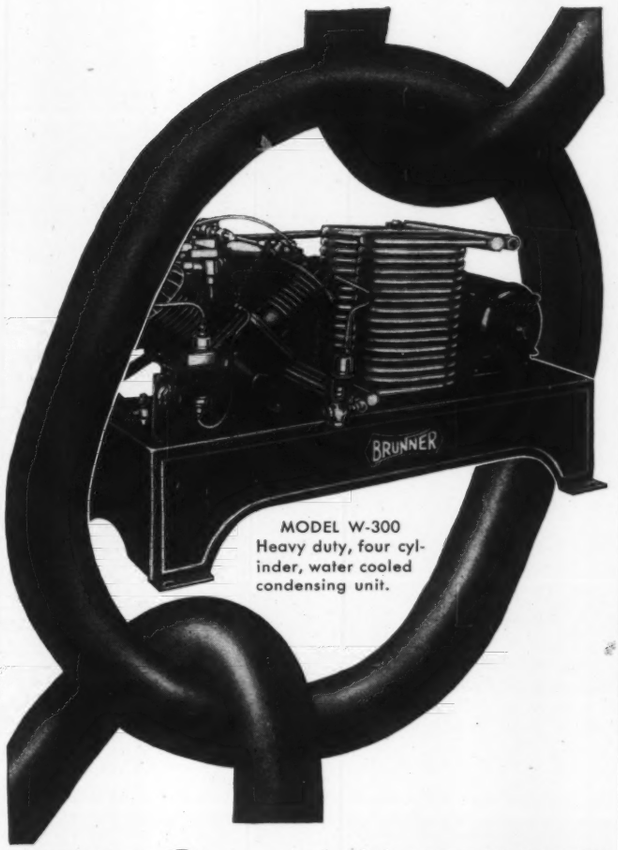
Speed Reduced in New Propeller Fan

No. 1369—Application for a patent on a "tear-drop" cross section propeller fan blade has been filed. The blade was developed under the direction of Fred Charavay.

Air tunnel tests have shown, Mr. Charavay reports, that the most economical operation of the new fan is achieved at approximately half the tip speed of the usual propeller type fan, without loss in air delivery. Tests also indicate, he says, that air delivery holds up against pressure above normal expectancy. The reduction in speed, plus design of the airfoil section, reduce the production of noise, it is stated.

For the present it is planned to offer it in standard single propeller style sizes up to 55 in. diameter. Adjustable pitch





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Heavy duty, four cylinder, water cooled condensing unit.

EXPECT *Dependable* STRENGTH IN THIS LINK OF THE "CHAIN"

An air conditioning system is only as dependable as its weakest link! Make sure the condensing unit YOU specify measures up in mechanical stamina with the other links... that it is geared up to economical year-in-year-out service. Brunner Condensing Units, backed by over a quarter century of sound engineering and manufacturing experience, measure up to today's exacting air conditioning requirements... A broad range of 1937 models for all installations up to 15 tons of refrigeration. Brunner Manufacturing Co., Utica, N. Y., U. S. A.

BRUNNER
Condensing Units

TWO BIG BUILDINGS INSTALL CENTRAL HEAT CONTROL

Baltimore's "City-Under-a-Roof" Gets Balanced Heating with Webster Moderator System

FLEXIBLE HEATING SCHEDULE

Temperatures in Each of Seven Heating Zones Regulated at Central Station

PROPERTY COVERS HALF-BLOCK

Baltimore, Md.—Comfort for ten retail establishments and more than 900 offices in Baltimore's "city under a roof" is provided with the Webster Moderator System as a result of a modernization program completed in 1936.

This property, which covers half a city block, consists of the Calvert and Equitable Buildings.

In this large installation, the Webster Moderator System controls the distribution of steam to seven heating zones and more than 1,700 radiators. Each zone has its own heating schedule, separately controlled and regulated from one central station. Distribution of steam throughout the system is accomplished evenly, rapidly and without overheating.

Calvert Building, Baltimore

George B. Simmons, president of the operating company, said:

"The Warren Webster Control System, with district steam, has produced more uniform and more comfortable temperatures than private plant operation. The present indications are that the savings estimated by our consulting engineers will be fully realized. The discontinuance of private plant operation has made available a considerable amount of space which is now producing valuable rental income."

Equitable Building, Baltimore

Webster Heating Modernization and the change to district steam were recommended and supervised by Edward L. Crosby, president of Henry Adams, Inc., consulting engineers for the properties. The modernization program was carried out by Wallace Stebbins & Sons, Inc., well-known Baltimore heating contractors. John R. Schnur is the building superintendent. Arthur E. Sawyer is chief engineer.

These before-and-after facts point the way to maximum comfort and economy in heating new buildings as well as in modernization of existing installations. Consult your architect, engineer or heating contractor. Or address

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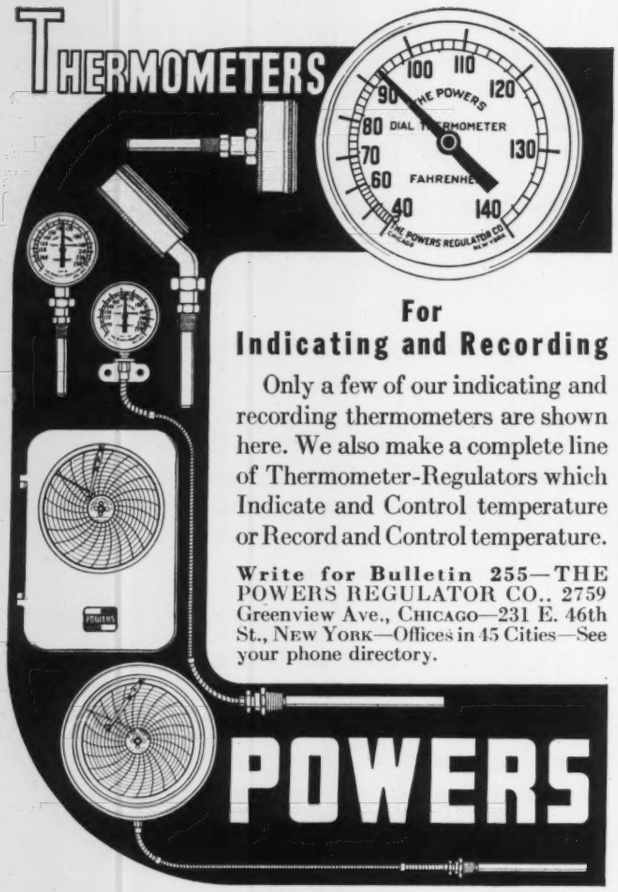
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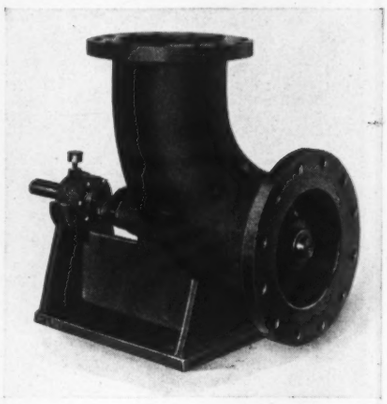
Randall Standard Pillow Block

Randall GRAPHITE PRODUCTS CORP.
Dept. 12IC 609 W. Lake St., Chicago, Ill.

fans, from 44 in. to 11 ft diameters, are also available. Adjustable pitch fans can be had with two, four and six blades.—Hartzell Propeller Fan Co., Piqua, Ohio.

Develops Elbow Propeller Pump

No. 1370—A new line of elbow propeller type circulating pumps to handle not only water but also semi-viscous liquids, especially liquors, sugar juices, paper stock and the like, is offered. These pumps may be installed in pipe lines for booster or circulating service, the small number of vanes and large openings providing a large streamline flow channel. Internal bearings and ball type thrust bearings are provided and the units are suitable for any type of drive, states the maker. Capacity ranges from 1000 to 2000 gpm at heads up to 20 ft.—Worthington Pump and Machinery Corp., Harrison, N. J.



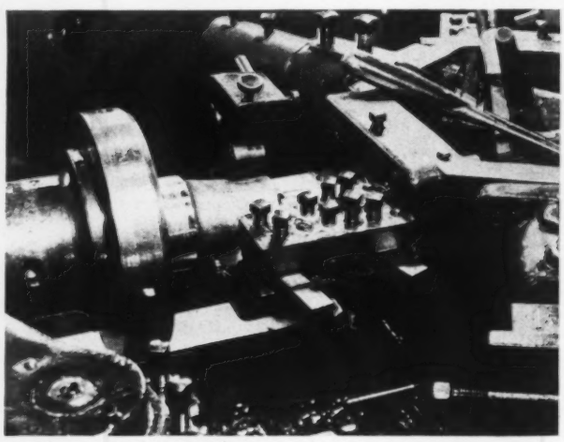
Announces Thread Cutting Screws

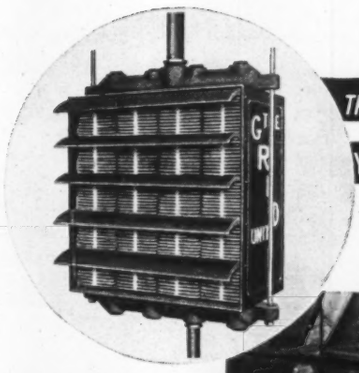
No. 1371—A screw that cuts its own thread in metals and plastics of practically any thickness has been announced. Its patented, thread-cutting slot, plus a special hardening process, eliminates the separate tapping operation normally required in the use of standard machine screws, according to the maker.—Shakeproof Lock Washer Co., 2501 N. Keeler Ave., Chicago, Ill.

New Alloy for Cutting Tools

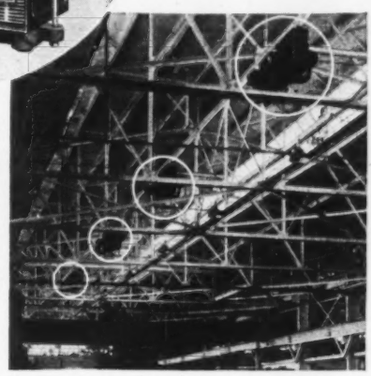
No. 1372—A new cobalt-chromium-tungsten alloy for metal cutting tools is known as "Haynes Stellite-2400." It is suitable and economical for roughing and finishing cast and forged steels; nitrided, stainless, and other alloy steels; cast iron and other malleable iron; says the maker.

For example, in an operation machining stainless steel poppet valve nozzle castings, the material was adopted in an effort to overcome tool breakage. Operating under exactly the same conditions as the facing and boring tools it replaced, it now turns out well over 50 pieces between grinds. The machining operations on this 4½ in. outside diameter casting include rough and finish turning two diameters, tapering, facing and boring. Time studies give the following conditions for facing and boring:





THE UNIT HEATER YOU'RE LOOKING FOR



Made to heat—not to leak, so that maintenance is practically nothing, GRID UNIT HEATERS are distinctive in that the "fin" or heating sections are special aluminum alloy, cast metal to metal bonded to high test alloy cast iron steam chambers. No dissimilar metals, therefore, are in contact with each other and steam — positively eliminating electrolysis that causes corrosion. Neither are there expanded, pressed, rolled, or soldered joints, or unions in them. And, GRID units can be placed in higher positions than other types (the illustration here shows them 44 feet from the floor). We'll gladly send you complete details, capacity tables and engineering data upon request.

THE UNIT HEATER & COOLER CO.
Wausau, Wisconsin
Offices in all principal cities

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The Conduit for Underground Steam Lines

Simplest
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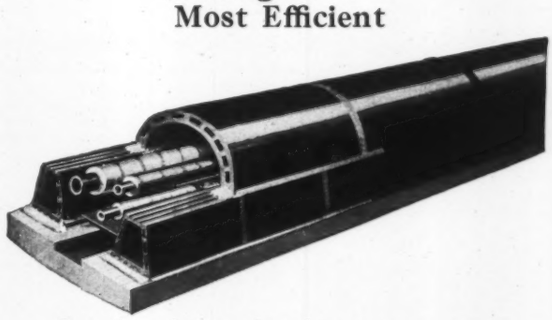

Complete data and estimates on request.

Sold and Installed by Johns-Manville Construction Units in all Principal Cities.

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Since the first Pomona Pump was made, wells have gone deeper, diameters have been made larger, heads have grown greater and capacities have increased. To meet such advancing requirements, Pomona engineers are always facing new horizons. With experience from yesterday — eyes on today — minds on tomorrow — the entire Pomona organization is constantly anticipating new conditions and making adjustments to them.

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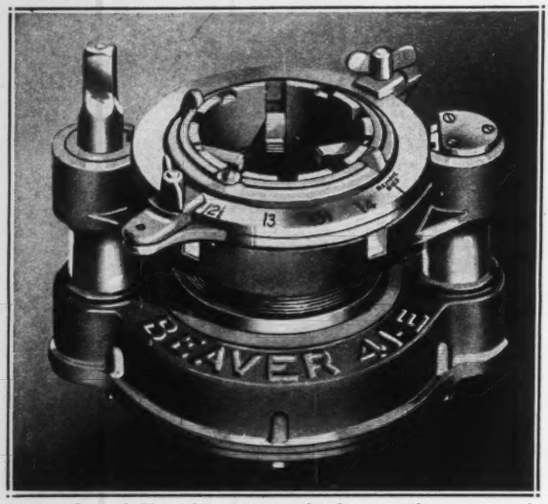
POMONA TURBINE PUMPS

MILWAUKEE VALVE COMPANY
MILWAUKEE *Manufacturers of* WISCONSIN
MILVACO Heating Specialties—APPROVED Bronze Valves

BEAVER No. 41-E 2½ to 4"



Beaver Geared Threaders are popular because they cut standard, under or over size, to meet variations in fittings, without affecting the length of thread—thus assuring tight joints. In No. 41-E, 2½ to 4-inch and No. 61-E, 2½ to 6-inch, the gears are fully enclosed and packed in graphite grease. Sand, chips or other foreign matter cannot get in the gear case to damage the gear and pinion. Thus, the principal cause of trouble in geared tools is eliminated. A patented Beaver advantage. Price No. 41-E, complete, $50.00—through your supply house.

BEAVER PIPE TOOLS

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Seal All
AIR DUCT JOINTS
with
PECORA CALKING COMPOUND
for effective Air Conditioning

IT will pay you to use this better calking compound. It is impervious to heat, cold and moisture and will not dry out, crack or chip when properly applied. Pecora Calking Compound is available in metal cartridges for use in the new Pecora High Pressure Calking Gun, a great time and labor saver.

For sealing furnace joints so they will be really gas tight, you can depend on PECORA ASBESTOS FURNACE CEMENT.

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Est. 1862 by Smith Bowen
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rpm—61 (equivalent to a surface speed at the outside diameter of 72 ft per min), feed—0.005 in. per rev., depth of cut—⅛ to ¼ in. Rough and finish turning are accomplished on a separate machine with approximately the same feed and depth of cut, but the surface speed is higher, being 125 ft per min. About 30 pieces are turned and tapered between tool grinds.

The illustration shows rough and finish turning and tapering a cast stainless steel valve nozzle, a standard operation at a large valve manufacturing plant.—Haynes Stellite Co., Kokomo, Ind.

New Form of Corkboard for Insulating Ducts

No. 1373—Illustrated is a new form of light, flexible corkboard sheets furnished in 12 in. by 36 in. size and ½ in. thickness, specially designed for the insulating of ducts. Its flexibility, which makes it easy to shape to the sharp curvatures encountered in duct work, is its feature.

The corkboard is factory coated on one face with a waterproof mastic finish to add strength and protect against moisture and air infiltration. This particular form of corkboard is recommended by the maker only for the insulation of ducts where the purpose is to prevent condensation; where refrigeration must be conserved, the insulation should be standard corkboard in heavier thicknesses.—Armstrong Cork Products Co., 994 Concord St., Lancaster, Pa.

Announces New Valves and Fittings

No. 1374—Three new valve lines and brass fittings for copper tubing have just been announced.

For severe service on small lines carrying steam, hot water, cold water, oil, gas and similar fluids a line of brass globe (No. 14½-P) and angle (No. 16½-P) valves with plug type disc of nickel alloy and body seat ring made of "Exelloy," a specially heat treated chromium iron, is offered. This combination of metals is considered ideal for seating surfaces, having excellent resistance to wear, temperature, galling and scoring, according to the maker, who states that they are harder, stronger, and tougher than metals ordinarily used in brass valves. Made in sizes ⅛ to 3 in., these valves are recommended for 150 lb steam working pressure and 300 lb on cold water, oil or gas lines.

New iron body globe and angle valves designed to withstand exceptionally severe service are also offered. The plug type disc is made of nickel alloy and the body seat ring of "Exelloy." These valves are recommended for 150 lb steam working pressure and 300 lb on cold water, oil or gas lines. They are made in sizes ¼ to 3 in., and also are recommended for throttling service. Interchangeability of parts is a feature.

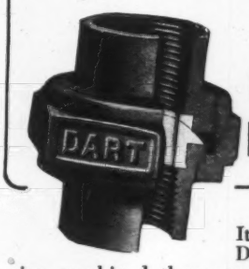
A line of brass screwed end globe and check valves for 350 lb steam pressure at 550 F is also new. These valves are designed especially for high pressure steam lines such as are used on oil and gas field boilers for deep well drilling operations. They also may be used on non-shock cold water, oil or gas lines up to 1000 lb. Their sizes range from ½ to 2 in.

The brass fittings for flared copper tubing were discontinued a few years ago by the maker but have been reinstated as a regular line. These fittings include elbows (90 and 45 deg), tees, couplings, reducers, adapters and flanging tools, in sizes ⅜ to 1¼ in.

PAY LE$S

for the

FINEST UNION MONEY CAN BUY



It pays to economize with Darts. For Darts have two bronze seats, first precision machined then *ground to a full bearing true ball joint.* Darts sit tight as often as installed.

Moreover, Dart bodies and nut are extra-heavy, air-refined malleable iron—built to resist pipe strains, wrench abuse, repeated use.

It takes extra manufacturing operations to make Darts prevent breakage, stretch, thread distortion, that permits no leakage, no loss of time. That's why Darts cost you less in service.

Send for one to try, at our expense. What size do you use most?

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FOR AIR WASHING

For air washers we recommend either ¼" Fig. 631 (female) or ¼" or ⅜" Fig. 629 (male pipe-illustrated) Brass nozzle. Capacities up to 189 G.P.H. @ 20 lbs.

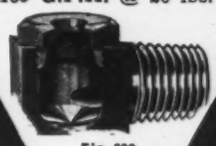

Fig. 629

For air conditioning work, Fig. F-27 is available in same capacities as H-261 and in brass and stainless steel.

For air conditioning work. Supplied in capacities .57 G.P.H. up @ 40 lbs. All brass nozzle.

Fig. F-27

Write for Catalog 6-A

¼" Fig. H-261

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2728 E. WESTMORELAND STREET, PHILADELPHIA, PA.

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In Air Conditioning and Refrigeration Controls . . .

Holes that look like caverns under a microscope are imperceptible to the naked eye. But this is just ONE of the many precise tests demonstrating the care and skill in the precision manufacture of every A-P Air Conditioning and Refrigeration Control.

Detail? Yes. But all necessary to keep A-P Controls up to the standard of efficient and accurate dependability that Refrigeration Experts have learned to expect from ALL A-P Controls.

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Somewhere in this broad line of modern, highly-efficient Turbine, Centrifugal and Reciprocating Pumps is exactly the equipment you need, no matter what your pumping problem. American-Marsh engineers can help you get results with UTMOST economy. We have done it a thousand times before! Write us for bulletins.

To better associate our Company name with our long established trade name—American-Marsh—we recently adopted the new Company name used in the signature below.

However, there has been NO CHANGE in financial structure, management, or quality standards maintained for over 60 years.

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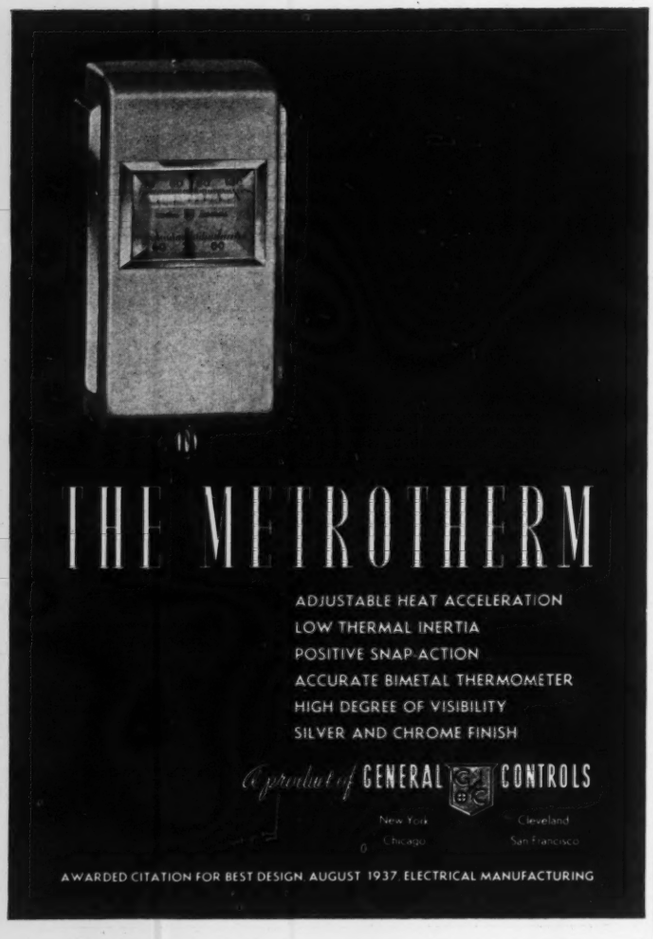
Centrifugal, Turbine, Steam, and Power Pumps
BATTLE CREEK . . . . MICHIGAN



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Here's the practical air conditioning system for the small or medium-sized home. Economical steel boiler radiator heat is supplied to bathrooms, kitchen and garage . . . all other rooms are air conditioned.
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Works: Oswego, N. Y. . . . Branches and Representatives in Principal Cities

Cast parts of these fittings are made in steam brass, while all compression nuts are forged brass, and the flanging tool is made of steel. The fittings are rated at 175 lb water working pressure.—Crane Co., 836 S. Michigan Ave., Chicago, Ill.

Book Reviews

Air Conditioning Manual Announced

["The Trane Air Conditioning Manual," by William Goodman, Air Conditioning Engineer. 325 pp., in loose-leaf binder. Published by the Trane Co., La Crosse, Wis. Price, $5.00.]

To collect, coordinate, organize, and to make comprehensible the store of knowledge on air conditioning is the function of this new air conditioning manual, which is to be available soon. It was written and compiled by William Goodman with the cooperation of the rest of the publisher's engineering and laboratory staffs. Available information was assembled and sifted, its inadequacies and shortcomings noted, and only the factual, tested data retained. Biased, catalog information was discarded, according to the publisher.

A feature is the Goodman psychrometric chart which, used with a specially designed ruler, enables solution of intricate air conditioning problems with rapidity. This graphical method of analyzing problems is described in detail. Although illustrative examples are given for almost every type of problem which might be required in air conditioning work, the methods employed are developed from a consideration of the physical ideas behind them.

New data are included on computing ordinary and solar heat gains, and among the material presented is information on refrigeration computations, properties of air, steam quantities for steam jet refrigeration, and use of water in air conditioning.

Heating, Ventilating and Air Conditioning Fundamentals

["Heating, Ventilating and Air Conditioning Fundamentals," by William H. Severns, Professor of Mechanical Engineering, University of Illinois. 1st ed. 1937. 467 pp., 6x9 in., clothbound. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. Price, $4.00.]

Presented as a text for use in undergraduate courses in the subject, Professor Severns has included in this new book some of the essential fundamentals supplemented with catalog data on commercial equipment to enable students to do some design work. A good selection of problems to be worked out is given at the end of each chapter.

In addition to data from various manufacturers, the author has drawn freely from the publications of the American Society of Heating and Ventilating Engineers, and the great amount of work that has been done at the University of Illinois on warm air heating, the testing of radiators, and the like.

Attention is given mostly to heating. The chapters included are essential definitions, laws, and properties of various media; factors affecting human comfort; heat transmission and air infiltration in buildings; calculation and estimation of building heat losses and heat gains; radiators and convectors; fuels, combustion, draft, and chimneys; heating boilers and appurtenances; pipe, pipe fittings, insulation, flow of steam in pipes, and piping details; heating with steam; heating with hot water; air conveying and air cleaning, air flow, fans, duct design, and air cleaners; ventilation; heating with warm air furnace systems; heating with central hot blast systems and unit heaters; humidification, dehumidification, and drying of materials; control of air temperature and humidity; and summer cooling of buildings.

In the descriptions of apparatus, the emphasis tends to be put on the individual items of equipment, rather than upon their use in the system as a whole.

REX-WELD
"Super-Service"
Vibration Absorbers
for
AIR CONDITIONING
MACHINERY

Stronger walls of uniform thickness and great flexibility make this Rex-Weld Flexible Metal Tubing Unit the ideal absorber for dampening vibration in air conditioning and refrigerating machinery. Produced under Rex-Weld exclusive process, of special alloy bronze. Send specifications for prices.

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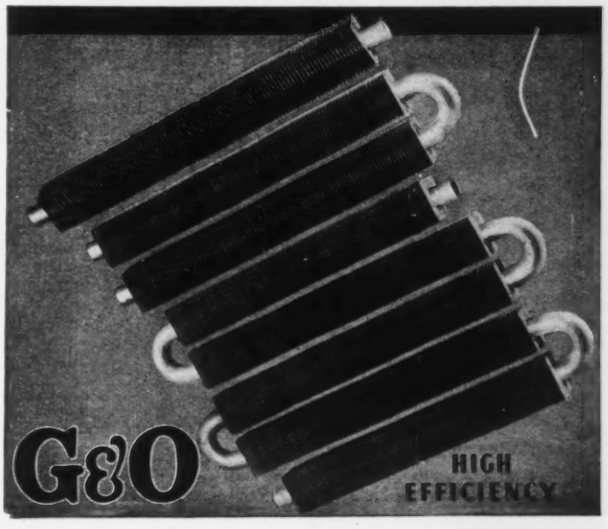

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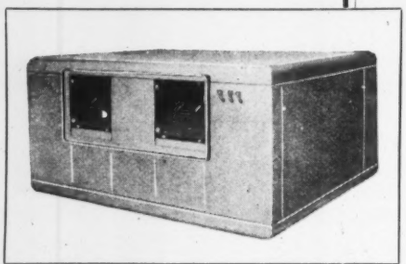
McQUAY
AIR CONDITIONING UNITS
(Suspended Blower Type)



This McQuay unit cools, dehumidifies, filters and circulates the air in summer; heats, humidifies, filters and circulates the air in winter.

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Descriptive Bulletin Upon Request

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Conventions and Expositions

Chemical Industries Exposition: December 6-11, Grand Central Palace, New York, N. Y.

Conference on Welding: December 9-10, Purdue University, Lafayette, Ind. J. D. Hoffman, Director, Department of Practical Mechanics, Purdue University, Lafayette, Ind.

Drying and Air Conditioning Symposium: December 27-28, University of Pennsylvania, Philadelphia, Pa. Under auspices of the Division of Industrial and Engineering Chemistry, *American Chemical Society.* Symposium Chairman, D. B. Keyes, Department of Chemistry, University of Illinois, Urbana, Ill.

Louisiana Engineering Society: Annual meeting, January 7-8, St. Charles Hotel, New Orleans, La. Secretary-Treasurer, A. M. Hill, 422 St. Charles Hotel, New Orleans, La.

Fifth International Heating and Ventilating Exposition: January 24-28, 1938, Grand Central Palace, New York, N. Y. Manager, Charles F. Roth, International Exposition Co., Grand Central Palace, New York, N. Y.

American Society of Heating and Ventilating Engineers: Annual meeting, January 24-28, Biltmore Hotel, New York, N. Y. Secretary, A. V. Hutchinson, 51 Madison Ave., New York, N. Y.

National Warm Air Heating and Air Conditioning Association: Winter convention, January 25-26, Roosevelt Hotel, New York, N. Y. Managing Director, Allen W. Williams, 50 W. Broad St., Columbus, Ohio.

American Society of Refrigerating Engineers: Annual meeting, January 25-27, Roosevelt Hotel, New York, N. Y. Secretary, David L. Fiske, 37 W. 39th St., New York, N. Y.

Western Metal Exposition and Congress: March 21-25, Pan-Pacific Auditorium, Los Angeles, Calif. Auspices American Society for Metals, W. H. Eisenman, Secretary, 7016 Euclid Ave., Cleveland, Ohio.

Recent Trade Literature

For your convenience in obtaining copies of bulletins, see coupon on page 142

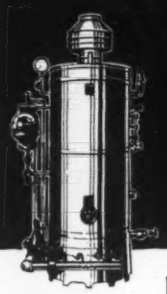
No. 2601. AIR FILTERS: Air-Maze Corp., 812 Huron Rd., Cleveland, Ohio. Leaflet describing features of this company's air filter panels and pointing out the importance of clean air.

No. 2602. AIR FILTERS: Independent Air Filter Co., Inc., 228 N. LaSalle St., Chicago, Ill. 8 p. data bulletin on automatic self-cleaning air filters describing and carefully illustrating construction, showing standard group arrangements and giving capacity and dimension tables.

No. 2603. ALLOYS: International Nickel Co., 67 Wall St., New York, N. Y. 32 p. bulletin of technical information on nickel and nickel base alloys and their use in the design of corrosion resistant machinery and equipment. Also a 24 p. bulletin on design and construction of heavy equipment of "Monel," nickel, and "Inconel." Complete and detailed information is given.

No. 2604. BELLOWS: Clifford Mfg. Co., 564 E. First St., Boston, Mass. 44 p. booklet on "Hydron" metallic bellows which are formed hydraulically, giving detailed information on characteristics and properties, technical data on bellows of different materials, presenting tables of sizes and characteristics, information on assembling, soldering and cleaning, and discussing diaphragms vs. bellows. The second part of the book is devoted

A HELPFUL HINT ABOUT



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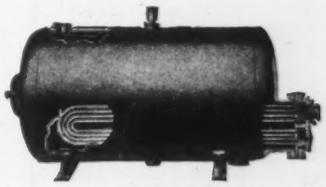

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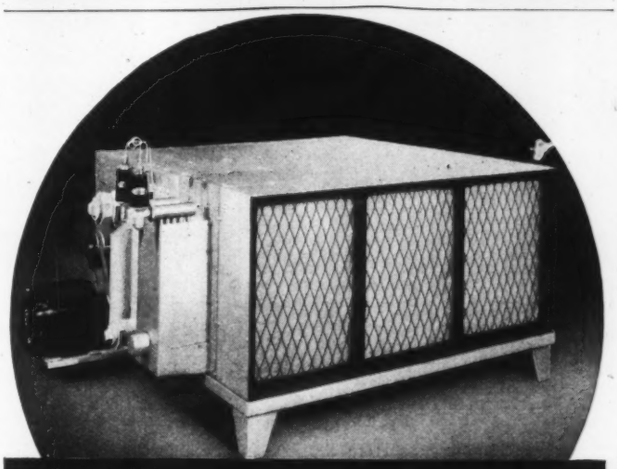

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FOR HEATING AND COOLING

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45 Years of Temperature and ★ Humidity Control ★

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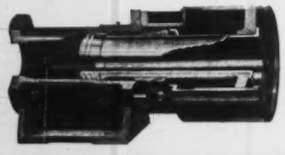

No interruption to service. Piston rings in internal guide hold the line pressure. Available in single or double slip joints for high pressures and high temperatures. Write for Bulletin No. 35-15H.P.

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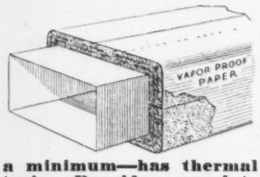

Reduces heat penetration to a minimum—has thermal conductivity of only 0.246 B.t.u.'s. Provides complete and lasting protection since it will not rot or decay. Fire and moisture resistant. Repels vermin. Extremely easy to apply because its flexibility permits ready shaping to the contours of the duct.

Also — OZITE HAIR FELT AIR DUCT LINING and DUCT INSULATION for all Sound, Heat and Cold Insulation purposes.

Write today for samples and specifications.

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MERCHANDISE MART CHICAGO, ILLINOIS

to bellows assemblies for remote control of temperatures, steam trap bellows, shafts and shaft seals, etc. An appendix gives pertinent data, including a large chart showing vapor pressure-temperature curves for typical filling mediums.

No. 2605. BOILER SERVICE UNITS: Roots-Connersville Blower Corp., 16th St. and Columbia Ave., Connersville, Ind. 6 p. bulletin on condensate return, make-up and boiler feed units for industrial plants using process steam, steam heating systems, etc. A feature of the units is the use of turbine pumps which will operate satisfactorily when handling water up to 210 F, according to the maker.

No. 2606. COOLING TOWERS: Marley Co., 1915 Walnut St., Kansas City, Mo. 20 p. bulletin on forced draft cooling towers illustrating numerous installations and features of design, describing details of the spray distribution, the multi-blade fans, the fan and damper housing, and other details.

No. 2607. FLOW METERS: Bristol Co., Platts Bridge, Waterbury, Conn. New bulletin illustrating applications and outlining special features of electric flow meters. Information on the construction and accuracy of the instruments is included.

No. 2608. GAS BOOSTERS: Spencer Turbine Co., 486 New Park Ave., Hartford, Conn. 4 p. bulletin on gas boosters to meet all conditions in gas operation and for handling acid fumes and poisonous, corrosive or explosive gases. Features of construction are described and a table of capacities presented.

No. 2609. GASKETS: Goetze Gasket & Packing Co., Inc., 60 Allen Ave., New Brunswick, N. J. Looseleaf data sheets showing cross sections and explaining construction of various gasket designs, and giving data on corrugated metal gaskets without asbestos, metal jacketed asbestos boiler gaskets, valve discs, compressed asbestos sheet packing, gasket cutting tools, corrugated metal asbestos gaskets, and woven asbestos metallic boiler gaskets.

No. 2610. HARD FACING: Haynes Stellite Co., Unit of Union Carbide and Carbon Corp., Harrison and Lindsay Sts., Kokomo, Ind. 8 p. booklet listing and briefly describing 18 of this company's publications dealing with hard facing alloys, cutting tools, and alloys for chemical processing equipment.

No. 2611. HEATING AND AIR CONDITIONING: Trane Co., La Crosse, Wis. Issues of "Weather Magic" for October and for November, including data on use of convectors, zoned air conditioning systems, unit heaters, bucket steam traps, solving a hangar heating problem, air conditioning a windowless building, use of convectors in greenhouses, etc.

No. 2612. HEATING EQUIPMENT: Sterling Engineering Co., 3738 N. Holton St., Milwaukee, Wis. Looseleaf folder including bulletins on steam heating equipment—thermostatic traps, blast traps, vents, packless radiator valves, radiator orifices, air line valves, check valves, gages, etc., for steam heating systems; vacuum pumps—describing features, operation, construction and the types available, and giving capacity and dimension tables; "Sterlco" temperature control for steam heating systems, showing diagrams of installations, size and capacity tables, etc.

No. 2613. HEATING SPECIALTIES: Trane Co., La Crosse, Wis. 36 p. catalog of steam heating specialties, including data on vapor heating systems, split systems, heat loss calculations, typical piping connections, etc. Various items of equipment are carefully described and illustrated, and dimensions, capacities and specifications are given.

No. 2614. INSTRUMENTS: Foxboro Co., 106 Neponset Ave., Foxboro, Mass. 16 p. bulletin describing seal of certification now attached to each of this company's instruments. Illustrations of more than 20 instruments representative of the line are included, and the various instruments are described.

No. 2615. INSULATION: Keasbey & Mattison Co., Butler Ave., Ambler, Pa. 54 p. substantially bound catalog on "K & M" magnesia and asbestos products. The various products are broken down into 10 general classes and the book touches the "high spots" of the line for quick and ready reference, as it is designed to be used in conjunction with a comprehensive series of pamphlets and price lists previously issued.

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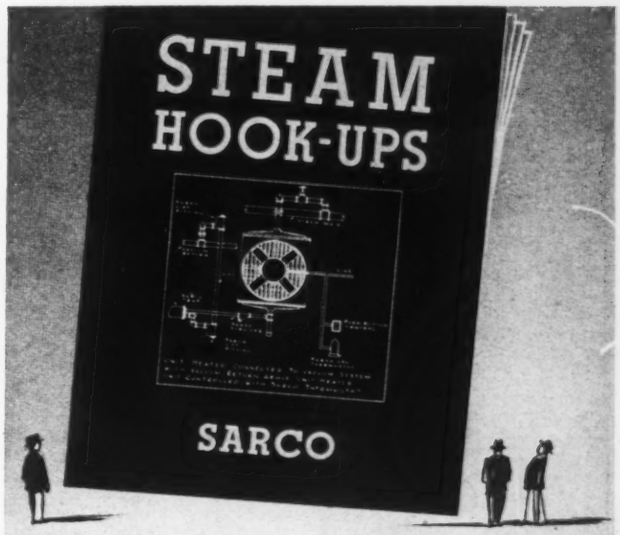

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14

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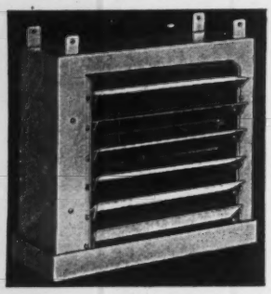

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2622	2623	2624	2625			

Name ..... Title .....

Company ....

Address .....

City ..... State .....

No. 2616. METAL BENDINGS: Wallace Supplies Mfg. Co., 1310 Diversey Parkway, Chicago, Ill. 8 p. bulletin on metal bendings and bending machines for various purposes.

No. 2617. METHYL CHLORIDE: R. & H. Chemicals Dept., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. 6 p. issue of "Artic Service News," Vol. 3, No. 4, containing technical information on the refrigerant methyl chloride and its characteristics.

No. 2618. MOTORS: Brown-Brockmeyer Co., Inc., 1098 Smithville Rd., Dayton, Ohio. 4 p. circular and price list on "B-Line" motors of various types.

No. 2619. MOTORS: Century Electric Co., 1806 Pine St., St. Louis, Mo. 24 p. booklet outlining in simple language the characteristics of fractional horsepower motors, giving reasons why these characteristics combined in a particular type of motor makes it suitable for the listed applications, and discussing it and illustrating the electrical and mechanical features of the various types of motors, which include repulsion start induction, split phase, capacitor, polyphase, and direct current.

No. 2620. RADIATOR VALVES: Fulton Sylphon Co., Knoxville, Tenn. 10 p. booklet on automatic radiator valves for exposed and enclosed radiators, illustrating and describing features, giving dimensions, showing typical installations, etc.

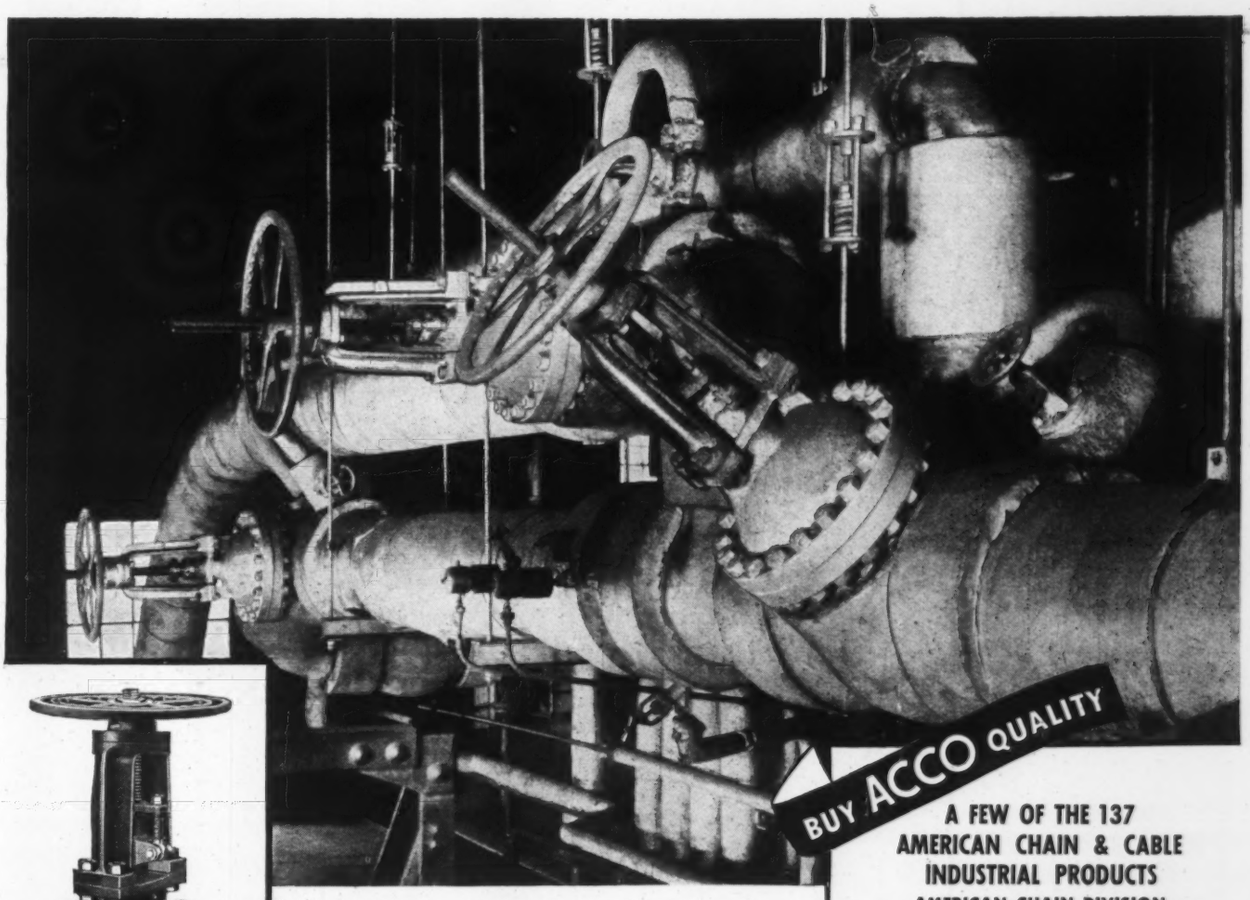
No. 2621. SLIDE RULES: Keuffel & Esser Co., Hoboken, N. J. Catalog of slide rules and calculating instruments, including a new psychrometric slide rule for simplifying air conditioning calculations.

No. 2622. WELDING: Hobart Brothers, Hobart Square, Troy, Ohio. 26 p. catalog on arc welding with new 40-volt arc welder and describing new "current saver" models with motor horsepower control.

No. 2623. WELDING AND CUTTING: The Linde Air Products Co., Unit of Union Carbide and Carbon Corp., 30 E. 42nd St., New York, N. Y. 60 p. booklet listing this company's distribution, sales and service facilities for oxy-acetylene welding and cutting items.

No. 2624. WRENCHES: J. H. Williams & Co., 75 Spring St., New York, N. Y. 28 p. booklet on how to select and use wrenches, containing information helpful to the mechanic and the tool buyer. Tables are given on correct wrench openings for U.S., S.A.E., American standard nut and cap screw sizes, and data on wrench types and their applications is presented.

No. 2625. ZONED CONTROL HEATING SYSTEMS: Webster Tallmadge & Co., Inc., 50 Church St., New York, N. Y. 24 p. booklet on zoned control heating systems for providing engineered heat distribution for large and small buildings. Manual, automatic or full automatic direct and remote control types and their operation are described, advantages of various types of zoning discussed, and typical case examples of results with this type of control are analyzed. The equipment required for such systems is illustrated and described.



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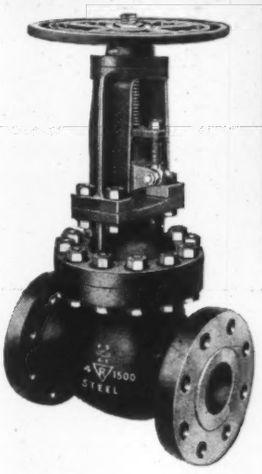

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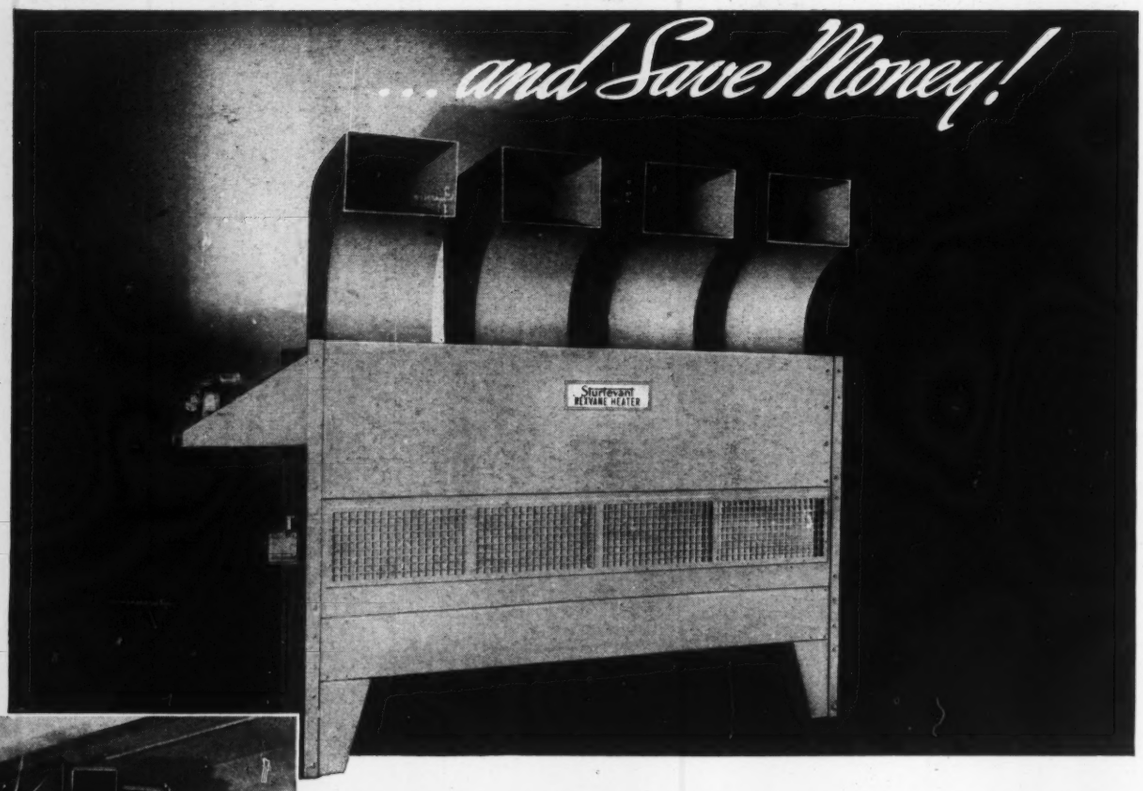

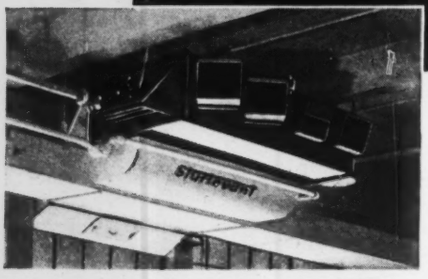

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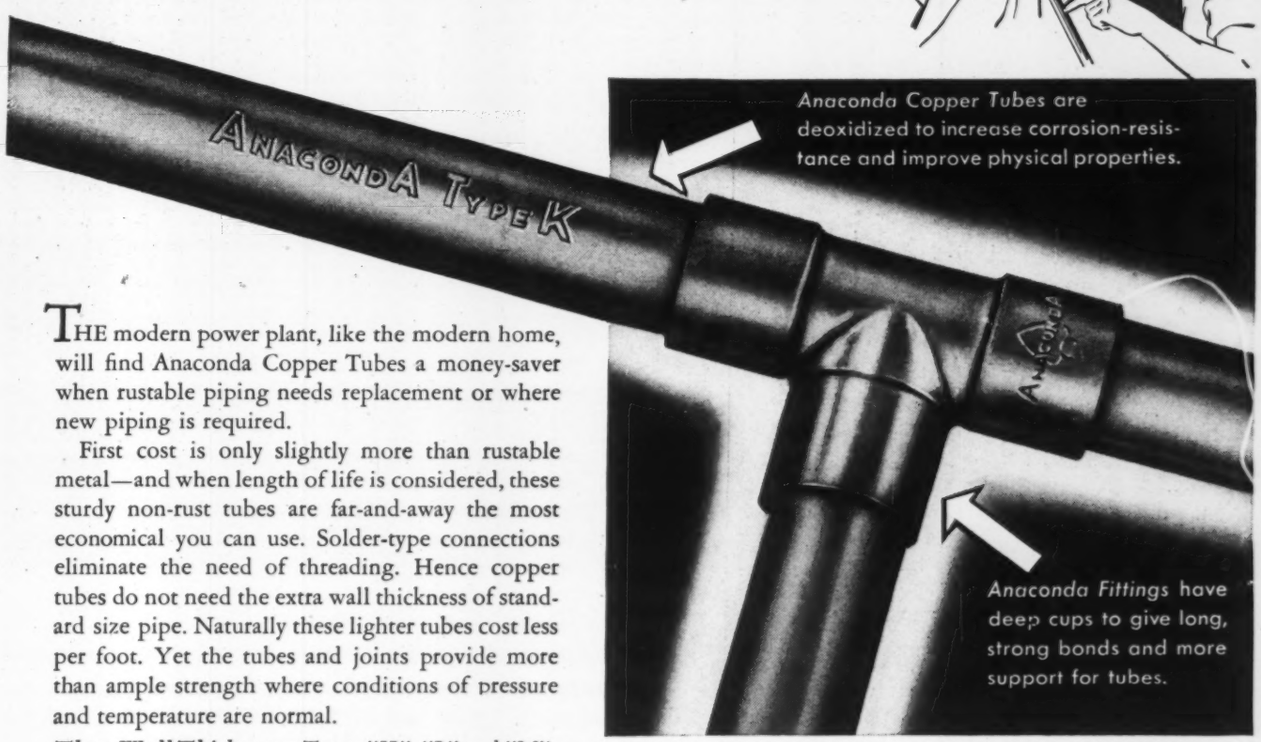
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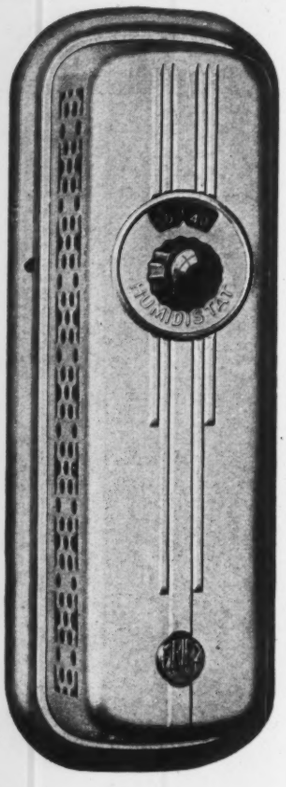

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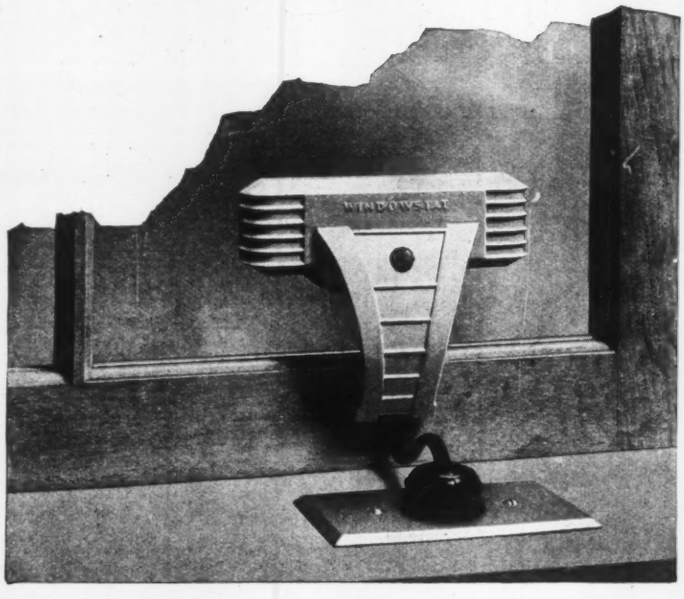

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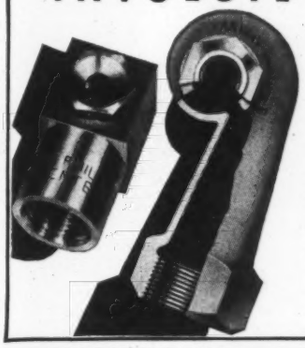

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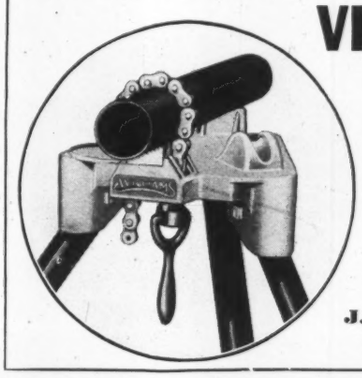

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Aerofin Corp. 129
Air Conditioning Products Co., Inc.. *
Air-Maze Corp. 140
Airo Supply Co....143
Air Reduction Sales Co.... *
Airtherm Mfg. Co....140
Allen-Bradley Co. .... *
Allis-Chalmers Mfg. Co.... 25
American Air Filter Co., Inc.... 26
American Blower Corp. .... *
American Brass Co. 117
American Chain and Cable Co., Inc...115
American District Steam Co....140
American Hair & Felt Co....140
American Radiator Co. .... *
American Rolling Mill Co.... 27
American-Marsh Pumps, Inc....135
American Steel & Wire Co.... 31
Anderson Co., The V. D....122
Anemostat Corp. of America.... *
Annis, Emmett F....142
Armstrong Cork Products Co.... 23
Armstrong Machine Works 18
Auditorium Conditioning Corp.... 40
Auer Register Co.... *
Automatic Products Co....135

Baker Ice Machine Co., Inc.... *
Baldor Electric Co.... *
Barber-Colman Co. .... *
Beaver Pipe Tools, Inc....134
Bell and Gossett Co.... 17
Binks Mfg. Co.... *
Bonney Forge and Tool Works....121
Bridgeport Brass Co..Inside Front Cover
Brunner Mfg. Co....131
Buffalo Forge Co. 39
Buffalo Pumps, Inc. .... *
Burnham Boiler Corp....123

Carbondale Div. of Worthington Pump & Mchry Corp....123
Carey Co., Philip.... *
Carnegie-Illinois Steel Corp.... 31
Carrier Corp. 42
Celotex Corp., The.... *
Century Electric Co.... 19
Chicago Metal Hose Corp....137
Clarage Fan Co....Inside Back Cover
Columbia Steel Co.... 31
Cork Import Corp.... *
Crane Co. 37
Curtis Refrigerating Machine Co....127

Dart Mfg. Co., E. M....135
Dayton Rubber Mfg. Co., The.... 33
Delco Products Corp.... 21
Detroit Lubricator Co. 30
Detroit Stoker Co. 146
Dole Valve Co., The.... 22
Dunham Co., C. A.... 36

Fafnir Bearing Co.... 14
Fairbanks Co., The.... 38
Fairbanks-Morse & Co.... 44
Fedders Mfg. Co....139
Fitzgibbons Boiler Co., The....136
Fretz-Moon Tube Co., Inc....125
Frick Co. .... *
Friez & Sons, Inc., Julien P....118
Fulton Sylphon Co.... 15

G & O Mfg. Co., The....137
General Controls Co. 136
General Electric Co. ....4 and 5
Grinnell Co., Inc....Outside Back Cover

Heating and Ventilating Exposition, Fifth International 34
Henry Furnace & Foundry Co., The..137
Hill, E. Vernon....127
Hoffman Specialty Co., Inc.... 8
Holtzer-Cabot Electric Co....138
Hotel Biltmore 142
Hussey & Co., C. G....128

Illinois Engineering Co. .... *
Illinois Testing Laboratories, Inc....143
Independent Air Filter Co.... *
Independent Register Co., The.... 20
Ingersoll-Rand .... *
Insto-Gas Corp. .... *

Jenkins Bros. 3
Johns-Manville .... *
Johnson Fan & Blower Corp.... *
Johnson Service Co. 32

Kelvin-White Co. .... *
Kuhns Brothers Co....137

Layne & Bowler, Inc.... *
Leland Electric Co.... *
Lincoln Electric Co., The.... *
Linde Air Products Co., The.... 35

McAlear Mfg. Co., The.... *
McQuay, Inc. 138
Malleable Iron Fittings Co....137
Marley Co., The.... 24
Mears-Kane-Ofeldt, Inc. 139
Midwest Piping & Supply Co.... 6
Milwaukee Valve Co....133
Minneapolis-Honeywell Regulator Co. 13
Monarch Mfg. Works, Inc....135
Mueller Brass Co....145
Mundet Cork Corp.... *

Nash Engineering Co.... 44
National Fan & Blower Corp....143
National Tube Co. 31
Nesbitt, Inc., J. J.... 7

Oster Mfg. Co....119
Oxweld Acetylene Co.... 35

Pains Fireworks Display Co., Inc.... *
Patterson-Kelley Co., Inc., The....139
Pecora Paint Co., Inc....134
Pomona Pump Co.... 133
Porter & Co., H. W....133
Powers Regulator Co., The..132 and 139
Practical Instrument Co.... *
Prest-O-Lite Co., Inc., The.... 35

Randall Graphite Products Corp....132
Reading-Pratt & Cady Co., Inc....115
Refrigeration and Air Conditioning Institute 141
Rempe Co. 142
Republic Steel Corp.... *
Revere Copper and Brass, Inc....141
Rhoads & Sons, J. E.... *
Ric-wiL Co., The....124
Ridge Tool Co....125

Sarco Co., The....141
Staynew Filter Co.... *
Streamline Pipe & Fittings Co....145
Sturtevant Co., B. F....116

Taylor Forge & Pipe Works.... *
Taylor Instrument Cos. .... *
Timken Steel & Tube Co.... *
Titusville Iron Works Co.... *
Torrington Mfg. Co.... *
Trane Co., The....10 and 11
Trimont Mfg. Co.... *
Tube-Turns, Inc. 12
Tuttle & Bailey, Inc.... *

Union Carbide and Carbon Corp.... 35
Union Carbide Sales Co.... 35
Unit Heater & Cooler Co....133
United States Steel Corp., Subsidiaries 31
United States Steel Products Co.... 31
Utica Radiator Corp.... *

Vilter Mfg. Co., The....120

Wagner Electric Corp....143
Walworth Co. 9
Waterloo Register Co.... *
Webster & Co., Warren....131
Westinghouse Electric & Mfg. Co.... *
Wheeling Steel Corp.... 29
Wiegand Co., Edwin L....141
Wiley & Sons, Inc., John....129
Williams & Co., J. H....143
Wilson, Inc., Grant....126
Wing Mfg. Co., L. J....130
Worthington Pump & Mchry. Corp...123

Yarnall-Waring Co. 143
Young Radiator Co. .... *
Young Regulator Co. .... *
Youngstown Sheet and Tube Co.... 16

PROVEN PERFORMANCE!

★STREAMLINE

TRADE MARK REG. U. S. PAT. OFFICE

COPPER PIPE AND FITTINGS

IMPORTANT—There is only one line of solder fittings manufactured under the trade name STREAMLINE. STREAMLINE Fittings were invented by engineers of the Mueller Brass Co., Port Huron, Michigan. These patented solder joint fittings are manufactured only by the Mueller Brass Co., and certain reliable concerns who hold a License under Mueller Brass Co. Patents. STREAMLINE is the Registered Trade Mark of this Company.

● There is no uncertain element about STREAMLINE. This revolutionary method of connecting copper pipe was invented and given to the trade eight years ago. Since that time it has been used in thousands upon thousands of installations throughout the United States and Canada with the utmost success and satisfaction to installer and user alike.

STREAMLINE'S exclusive method of bonding to the pipe is one of the main reasons for its outstanding success in the manufacture and installation of air conditioning and refrigeration equipment. It is the only fitting on the market with the true visual inspection feature.

STREAMLINE Fittings carry with them their own indisputable proof of a thoroughly bonded leak-proof joint. The mechanic installing STREAMLINE Fittings can tell visually that the joint he has just made is leak-proof. All that is necessary is for him to comply with certain simple rules—and the result is automatically certain. There is no guesswork about it.

You know that copper is ideal material for the majority of air conditioning and refrigeration work, but do you know the advantages of the STREAMLINE way in installing? Try it on your next job and prove it to your own satisfaction. ORDER STREAMLINE AND INSIST UPON GETTING IT.

FOR PLUMBING HEATING AND

STREAMLINE
PIPE AND FITTINGS DIVISION
MUELLER BRASS CO.
PORT HURON, MICHIGAN

Air Conditioning

$1407.00 SAVED with DETROIT LoStoker...

More testimony to the unequalled measure of value which Detroit Stokers provide.

READ THIS LETTER →

The O'Sullivan Rubber Co., Inc.
O'SULLIVAN'S RUBBER HEELS AND SOLES
WINCHESTER, VA.

March 26, 1937

Detroit Stoker Company
General Motors Building
Detroit, Michigan

Gentlemen:

It took us about eight months to decide what stoker to install under our 150 HP H.R.T. Boiler in our Winchester, Virginia, Plant, but only one month's use to prove that we had made a wise decision by installing a Detroit Stoker and that our savings in coal were far beyond what we had expected.

In addition to the savings in coal and labor, we at all times have a constant steam pressure which is extremely important in a manufacturing process such as ours.

The coal records submitted to you will speak for themselves and may be used as you see fit in your endeavor to save mamufacturers money by installing Detroit Stokers.

Very truly yours,

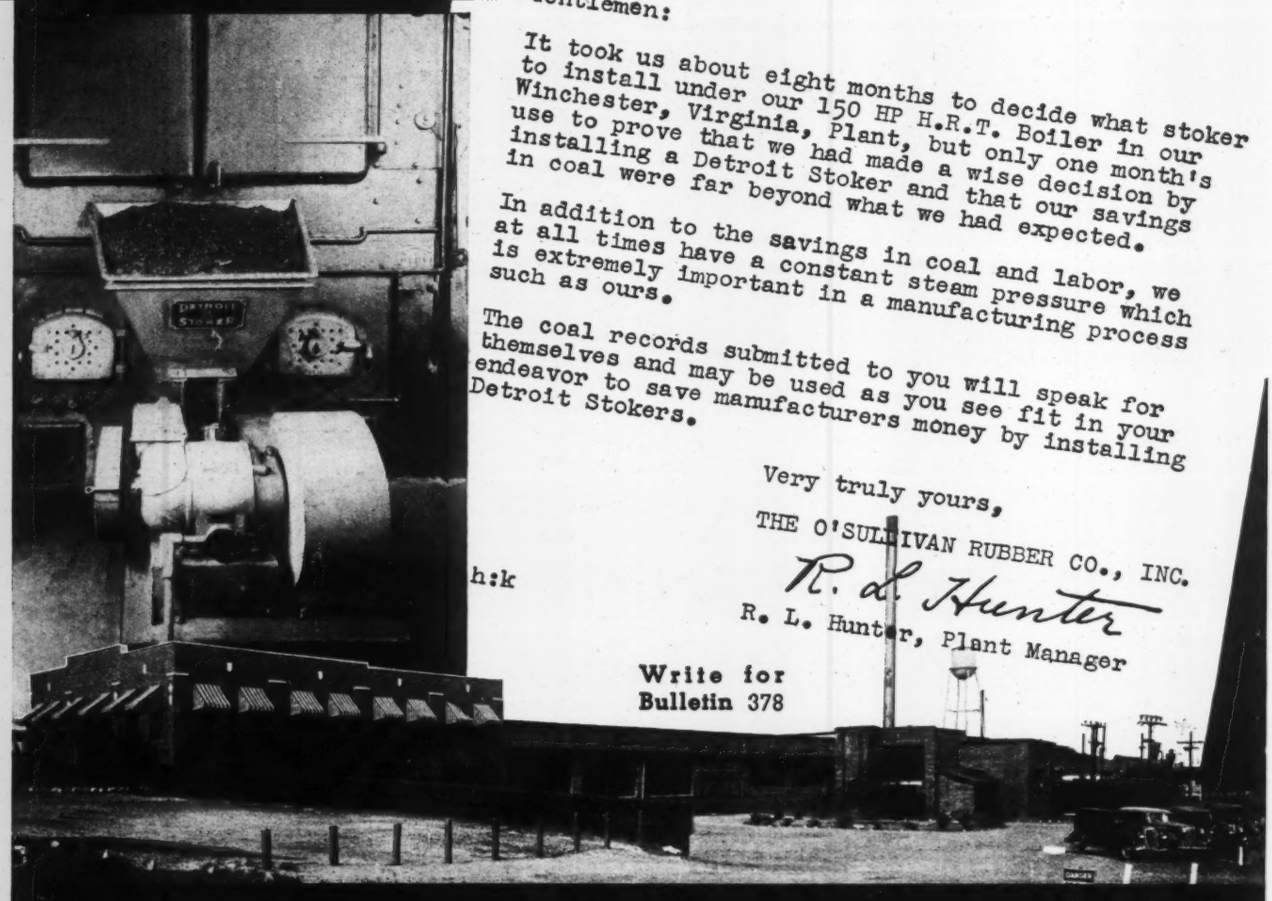
THE O'SULLIVAN RUBBER CO., INC.

h:k

R. L. Hunter

R. L. Hunter, Plant Manager

Write for Bulletin 378



DETROIT STOKER COMPANY

Fifth Floor, General Motors Building, Detroit, Michigan • Works at Monroe, Michigan
District Offices in Principal Cities • Built in Canada at London, Ontario

NEW JENKINS 'ARMOR-SEAT'

Defeats Toughest Valve Enemies

This Jenkins Valve has a PLUG SEAT made of Jenkins JX500 stainless steel EXCEEDING 500 BRINELL HARDNESS

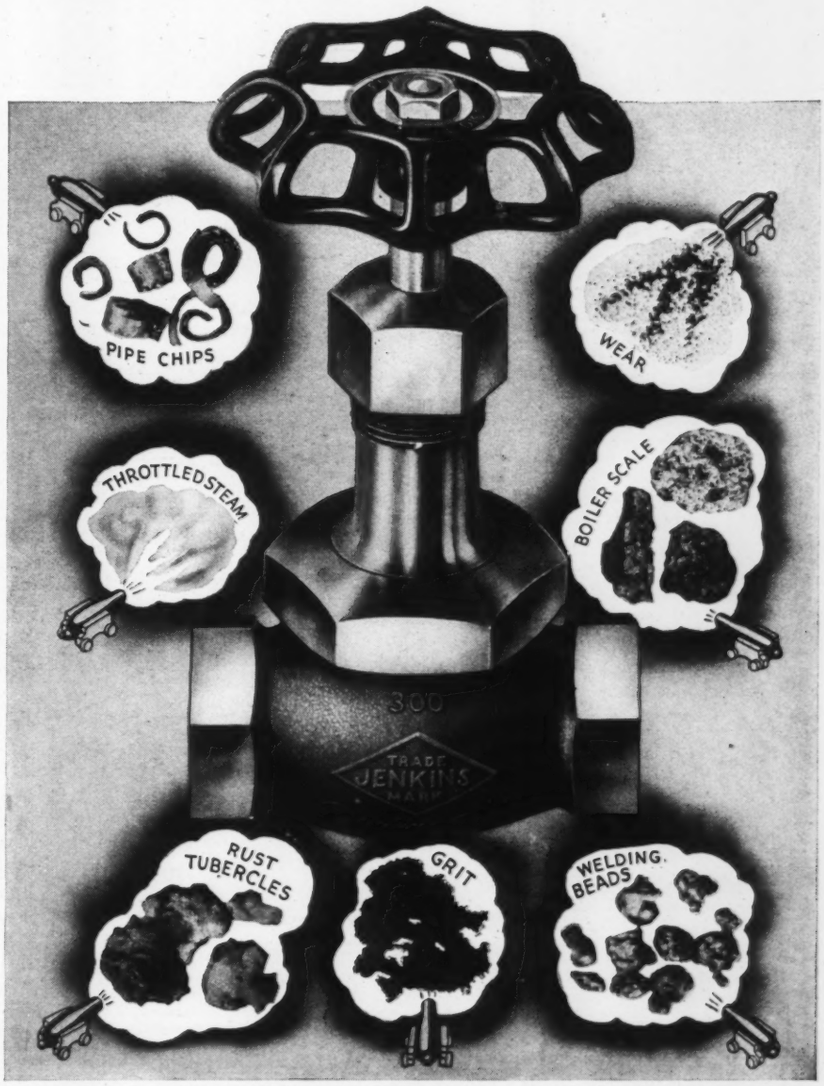
In presenting this Fig. 976 Plug-Seat Valve, Jenkins Bros. is confident that it is as near to being wear-proof, maintenance-proof and trouble-proof as a stock valve can be made. Back of it is a long period of development and testing to prepare it for the toughest services.

Natural enemies of valve seats such as boiler scale, pipe chips, grit and other substances commonly encountered in pipe lines, cannot injure the seating parts. Plug and seat ring are made of Jenkins JX500, a superior stainless steel having a Brinell hardness in excess of 500. Maximum wear-resistance is obtained and maintenance, due to seat damage, is reduced to the lowest possible degree.

Put this Jenkins to a service test on the worst place you know... continuous throttling for pressure reduction or free blow duty such as soot blowers, injectors, heating coils, or on any steam line where close regulation is required. Fig. 976 is specially recommended where such severe service is encountered. The JX500 plug and seat practically nullify wear and almost entirely eliminate danger of wire drawing and cutting.

If you have a tough valve job we ask only that you let this new Fig. 976 show what it can save you in maintenance and replacement expense. Ask your supply house for complete information, or write us.

JENKINS BROS., 80 White Street, New York; 510 Main Street, Bridgeport; 524 Atlantic Ave., Boston; 133 North Seventh Street, Philadelphia; 822 Washington Boulevard., Chicago; JENKINS BROS., Limited, Montreal, Can.; London, England



Illustrated is Fig. 976 for 300 lbs. W.S.P., or 600 lbs. O.W.G.

HOW HARD IS 500 BRINELL? Nothing that would conceivably get into the valve could scratch the Jenkins JX500 stainless steel seat. Compare 500 Brinell hardness with the hardness of some substances which do get into pipe lines... boiler scale, pipe chips, welding beads, rust tubercles, iron oxides... even with other familiar objects that are softer, such as a common nail which is under 200 Brinell hardness.

Jenkins Valves MADE FOR LIFETIME SERVICE

"WHAT make of electric motors do you prefer?" an impartial agency asked 788 men in business and industry. "GENERAL ELECTRIC," answered 61.5 per cent, as compared with 21 per cent for the make that came second.
RESTAURANT OWNER
INDUSTRIAL EXECUTIVE
OFFICE-BUILDING MANAGER
DEPARTMENT-STORE OWNER

You Can Cash-in On Their Preference

THESE men are typical of your customers—the purchasers of air-conditioning installations. They're typical, too, of the business men who have expressed a decided preference for G-E equipment. It's a preference which you can cash in on by tipping sales your way through the use of G-E motors and control.

No Idle Claim

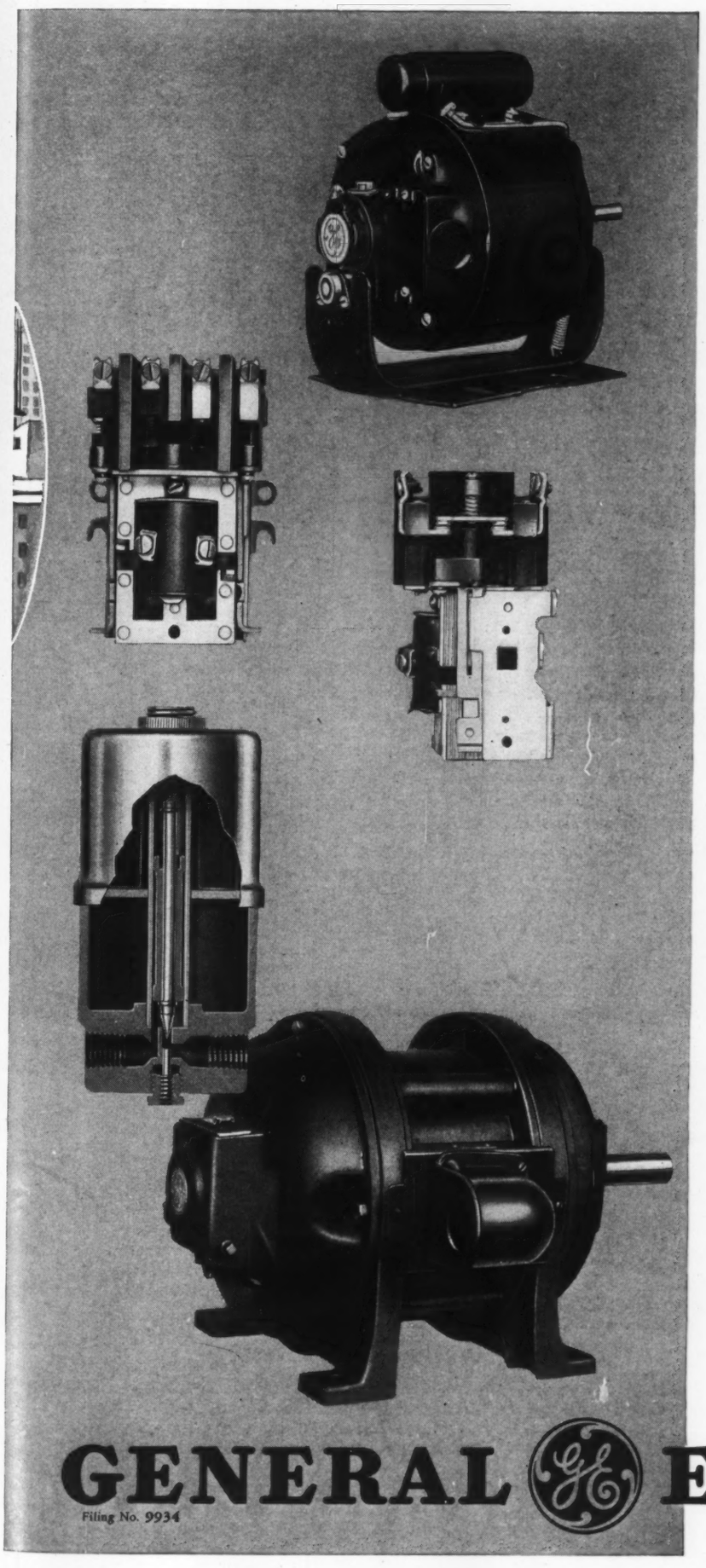
Our claim for acceptance by your customers is no idle statement, but is based on numerous surveys by impartial agencies. We've given the results of one survey in the box above. In another survey, a leading publisher asked 10,000 motor buyers, "Considering quality, price, and service, when you are next in the market for motors and control, which manufacturers will you ask for quotations?"

Eighty-five per cent included General Electric in their answer. Fifty-five per cent made it first choice, as compared with 20 per cent for the manufacturer that ranked second.

Tip the Sales Your Way

When you consider the preference expressed in these surveys, it isn't surprising to find that the use of G-E equipment helps sell air-conditioning installations more easily—tips sales your way when they hang in the balance. General Electric, Schenectady, N. Y.

HEATING, PIPING and AIR CONDITIONING, published monthly by Keeney Publishing Co., 6 N. Michigan Ave., Chicago, Ill. Subscription rates: U. S. and possessions, Canada, Mexico, Central America, South America. $2.00 per year; other, $4.00. Current copies, U. S. and possessions, 25 cents. Back numbers, 50 cents. December, 1937. Vol. 9, No. 12. Entered as Second Class matter May 18, 1929, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.



You can't beat this capacitor-motor as a smooth, quiet drive for small compressors, fans, or pumps. It has the resilient, sound-isolating base that makes the motor especially suitable for unit room coolers.

★

Shown at the left, in both side and front views, is a compact magnetic switch for relaying control circuits and for controlling small motors. The use of a pole-shader and a laminated, silicon-steel, E-shaped magnet makes its operation quiet. This switch is only one of the many G-E control devices that are ideally suited for air-conditioning installations.

★

G-E electric or Thrustor valves are available for pipe sizes up to ten inches. The sectional view of the small electric valve at the left shows how the plunger in this type of valve is sealed in the brazed tube which contains the controlled fluid. This construction prevents hum and results in quiet operation.

★

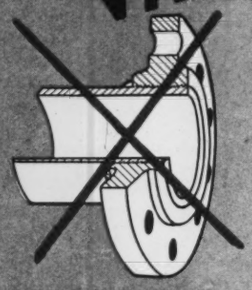
G-E Type KG motors have the high starting-torque and low starting-current characteristics needed for operating moderate-sized pumps, fans, and compressors. By using G-E motors of any size, you get not only reliable drives, but also the valuable sales aid mentioned on the opposite page.

GENERAL ELECTRIC

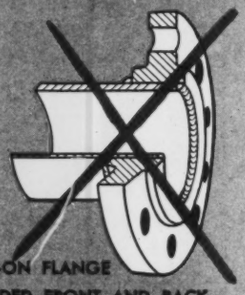
Filing No. 9934

011-249

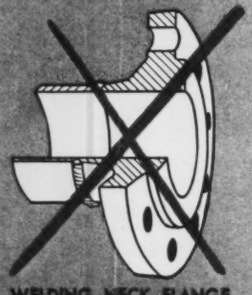
MIDWEST VAN STONE WELDING NIPPLE makes the *ideal* flanged joint for welded piping systems



SCREWED AND WELDED FLANGE



SLIP-ON FLANGE
WELDED FRONT AND BACK

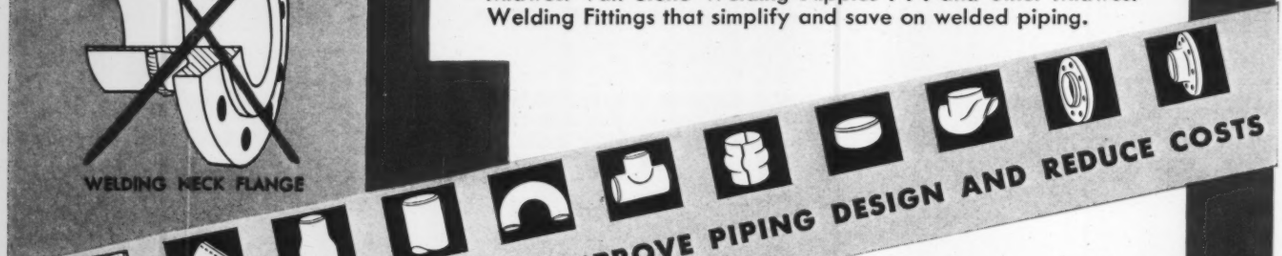


WELDING NECK FLANGE

For making connections to boilers, pumps, valves and other flanged outlets (and where piping must be frequently cleaned or inspected for corrosion), Midwest Van Stone Welding Nipples have a tremendous advantage over flanges that are welded to the pipe (see drawings at left). The swivel flange of the Nipple makes it unnecessary to accurately line up the bolt holes before welding; "setting up" is simple and quick because no special clamps or jigs are required to hold the face of the flange absolutely perpendicular to the axis of the pipe. The result is a real saving in time and cost of welding.

Another important economy is in erection. Field organizations report a saving of 25% in erection time for making up a joint using Midwest Van Stone Welding Nipple in comparison with flanges rigidly fixed to the pipe; this saving is even greater when the flanges are on bends.

Ask for Bulletin WF-36 which gives complete data regarding Midwest Van Stone Welding Nipples . . . and other Midwest Welding Fittings that simplify and save on welded piping.

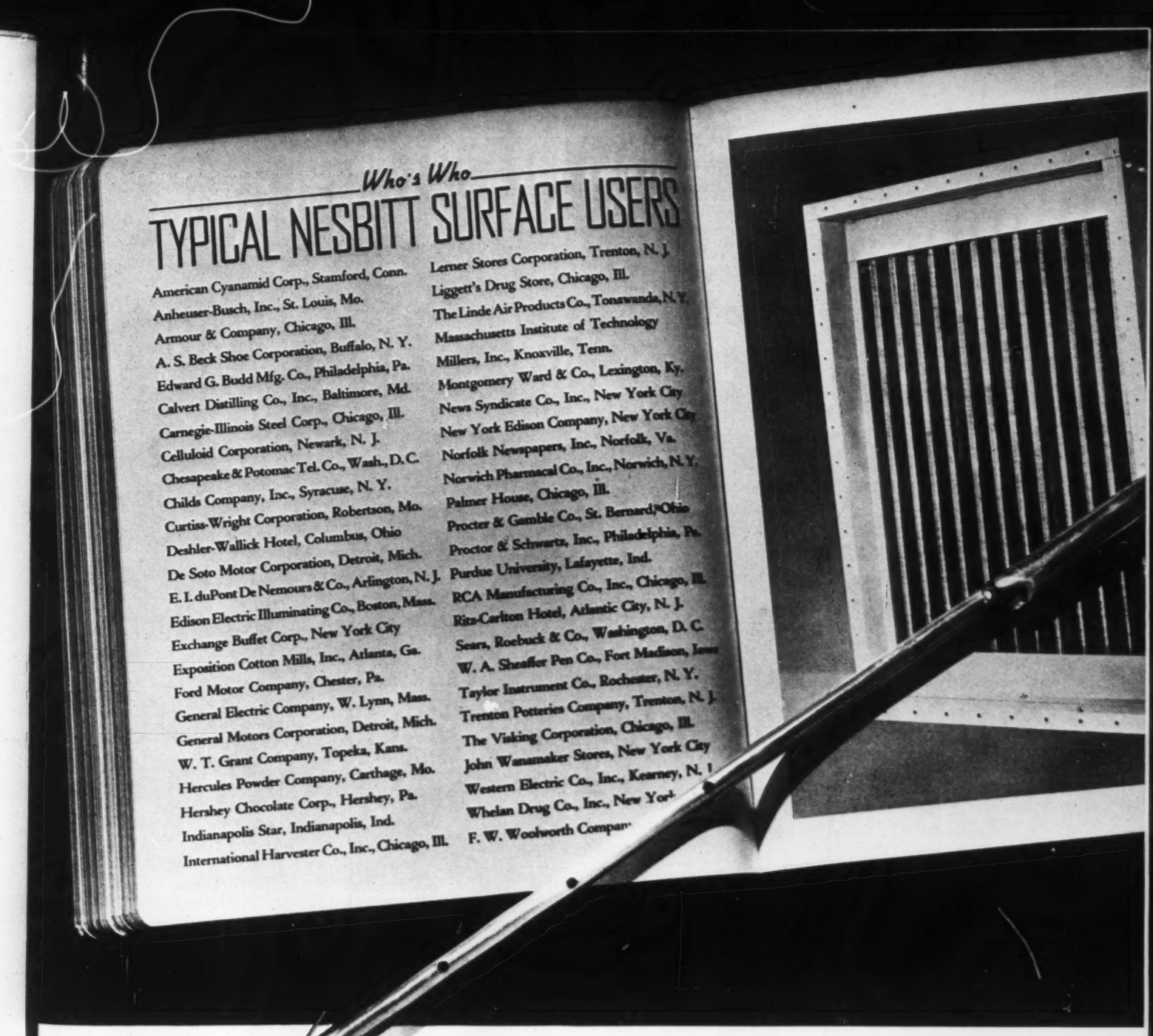


MIDWEST WELDING FITTINGS IMPROVE PIPING DESIGN AND REDUCE COSTS

MIDWEST
PIPING & SUPPLY COMPANY, Inc.

Main Office: 1450 So. Second St., St. Louis, Mo.

Plants: St. Louis, Passaic (N. J.) and Los Angeles • Sales Offices: Chicago—946 Marquette Bldg. • Houston—1716 Second National Bank Bldg. • Los Angeles—520 Anderson St. • New York—(Eastern Division) 30 Church St. Tulsa—533 Mayo Bldg.


Who's Who
TYPICAL NESBITT SURFACE USERS
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Anheuser-Busch, Inc., St. Louis, Mo.
Armour & Company, Chicago, Ill.
A. S. Beck Shoe Corporation, Buffalo, N. Y.
Edward G. Budd Mfg. Co., Philadelphia, Pa.
Calvert Distilling Co., Inc., Baltimore, Md.
Carnegie-Illinois Steel Corp., Chicago, Ill.
Celluloid Corporation, Newark, N. J.
Chesapeake & Potomac Tel. Co., Wash., D.C.
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Exposition Cotton Mills, Inc., Atlanta, Ga.
Ford Motor Company, Chester, Pa.
General Electric Company, W. Lynn, Mass.
General Motors Corporation, Detroit, Mich.
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Hercules Powder Company, Carthage, Mo.
Hershey Chocolate Corp., Hershey, Pa.
Indianapolis Star, Indianapolis, Ind.
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Taylor Instrument Co., Rochester, N. Y.
Trenton Potteries Company, Trenton, N. J.
The Viking Corporation, Chicago, Ill.
John Wanamaker Stores, New York City
Western Electric Co., Inc., Kearney, N. J.
Whelan Drug Co., Inc., New York
F. W. Woolworth Company

The Proof of the Product Is in the Using Thereof

Signal Acceptance

THE "Who's-Who" of Nesbitt Surface users presents a picture full of meaning for all who employ fan-system heating, ventilating, and air-conditioning. Within a comparatively short time of its introduction, Nesbitt Heating Surface with Steam-distributing Tubes has been used successfully by many leading industrial firms, hotels, stores, and schools, of which the above fifty names are representative.

The special steam-distributing tubes inside the regular condensing tubes of Nesbitt Surface assure complete and uniform distribution of even the smallest amount of steam under modulating valve control, thus making it possible to control the air-stream minimum temperature and to prevent surface freeze-ups without the use of preheaters. Also, discharge temperatures are UNIFORM over the entire face of the surface; system results are greatly improved; installation and operating economies are effected.

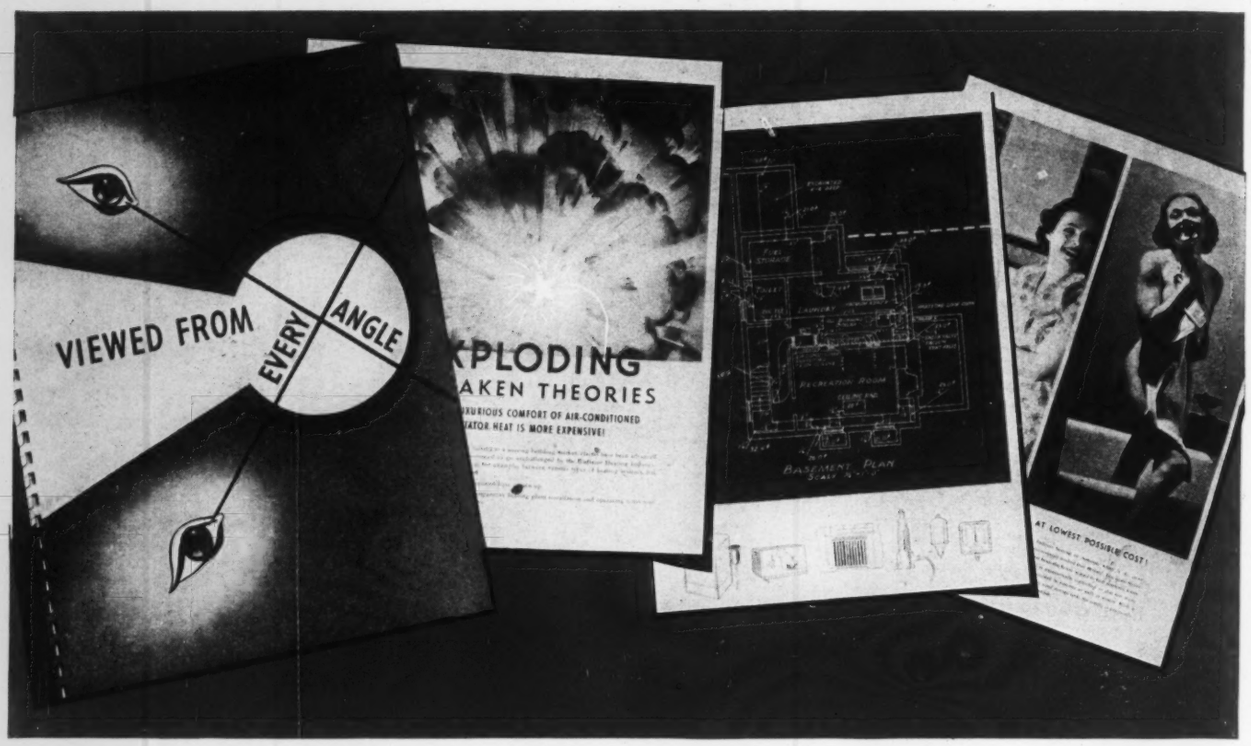
If you have not tried this revolutionary heating surface, why not start a "new page" for 1938? Send for engineering data.

JOHN J. NESBITT, INC., HOLMESBURG, PHILADELPHIA, PA.

NESBITT HEATING SURFACE

with Steam-distributing Tubes

Sold by leading manufacturers of fan-system apparatus



THE MOST POWERFUL SELLING STORY EVER PRESENTED FOR VACUUM HEAT

There is no substitute for the features which have made Hoffman Vacuum Valves the choice of Heating Contractors for nearly a quarter century. Double Air-Locks, leak-proof Double Shell and Six Speed Venting provide the high sustained vacuums and "balanced" steam distribution necessary for most economical vacuum heating.

Have you read "Viewed from Every Angle"? It's the booklet that ends all controversy over the merits of radiator and non-radiator heat. Crammed with facts which show conclusively that Hoffman Vacuum Heat with Air Conditioning will deliver *more comfort for much less money.*

You can lay this book before a prospect and prove with black on white figures that a Hoffman One-Pipe Vacuum System costs less, in the long run, to install, maintain and operate—and offers full value in healthful *radiant* heat. All explained in simple language the home owner can understand.

HELPS SELL MODERNIZING JOBS

The facts presented in "Viewed from Every Angle" work equally well in selling an owner on modernization with Hoffman Vacuum Valves. This book is a complete sales promotion which will work its head off for every Heating Contractor who uses it. Write for your copy at once. Hoffman Specialty Co., Inc., Dept. FG-12, Waterbury, Connecticut.

HOFFMAN
VACUUM VALVES

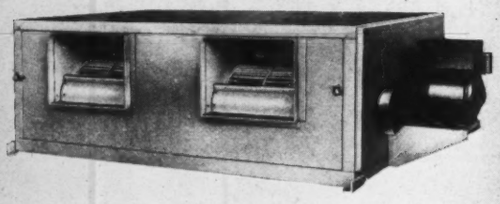
The Quality Line of HSCo *Heating Specialties*

Sold everywhere by leading wholesalers of Heating and Plumbing equipment

LOWER YOUR INVENTORY INVESTMENT
with Walworth A. A. R. Valves
BIG STRONG ... RELIABLE
WALWORTH
REORDERING MADE EASY...
For the "DIFFICULT" Liquids...
ELIMINATE VALVE TROUBLE ON PIPE LINES
Built for Tou
..the WALCO
loses its
STILLSON
GATE VALVES
WALWORTH
YOUR PIPING!
Run is easier... and quicker... and leak-proof ...with Walseal
WALWORTH
FAREWELL TO LEAKY VALVES!
IN THESE NEW BRONZE VALVES
WALWORTH
WALWORTH
Compliments of the Season and may 1938 bring you Health, Happiness and Prosperity . . .
WALWORTH
WALWORTH COMPANY
60 EAST 42nd STREET, NEW YORK
VALVES FITTINGS and TOOLS
Backed by 91 Years' Service
DISTRIBUTORS IN PRINCIPAL CITIES THROUGHOUT THE WORLD

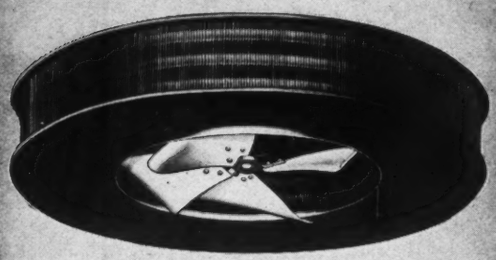
FOUR REASONS FOR

. . . . Serving the Heating, Cooling and Air Conditioning Industry from 70 U. S. offices.



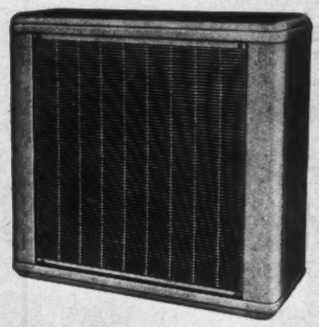
For Every Purpose Air Conditioners

You will find Trane Air Conditioning installations in every state in the Union, in many foreign countries, solving such widely different problems as the conditioning of a home, a modern train, a battleship, or the heating and ventilating of a school building. Because of its flexibility, Trane Air Conditioning Equipment can be adapted to meet all conditions and all budgets. Ask for Trane Air Conditioning Bulletins, stating intended use of equipment.



Unit Heaters

Trane offers the most comprehensive line of Unit Heaters available to the industry. Includes a complete range of sizes of standard propeller and blower type units, and the sensational new Trane Projection Heater. The Projector initiates a new efficiency and a new idea of comfort, principally due to its exclusive design. This makes possible high ceiling mounting, resulting in complete circulation and re-circulation to the breathing area of hot ceiling air, usually wasted. Similar in operating principle is the Trane Multiple Projection Heater, incorporating two or more fans in a single, compact mounting, having all the features of the blower type without its weight and cost. Ask for Trane Bulletins No. 284 and 294.

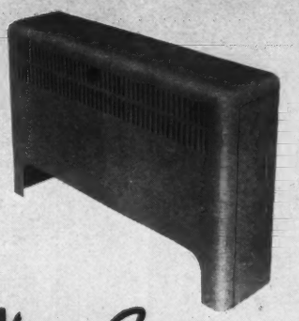


The Trane Propeller type Unit Heater shown here comes in over sixty different styles and sizes, with the most complete range of capacities commercially available. Ask for Bulletin No. 85.

IN HEATING AND AIR

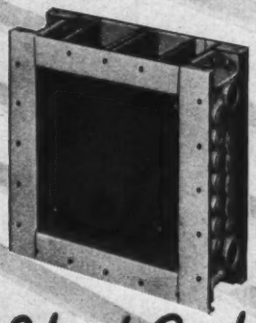
Address The Trane Company, 2004 Cameron Avenue, La Crosse, Wis.

TRANE LEADERSHIP



Non-Ferrous Convectors

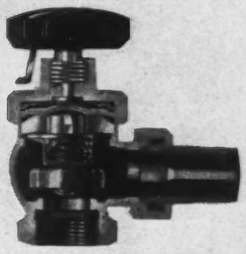
Trane Non-Ferrous Convectors have completely revolutionized heating standards and efficiency. Trane Coils provide transfer surfaces that make possible concealed or space saving construction, quicker response and greater heat output. One large city has used over 60,000 Trane Convectors in the last five years. Ask for Trane Convector Bulletins.



Blast Coils

Trane Coil construction, which has gained wide acceptance in central heating and ventilating systems, in Trane Convectors, in Unit Heaters and Air Conditioners, is also available for application in process and product conditioning. The non-ferrous tube and fin construction of Trane Coils, without use of solder, enables them to withstand both high and low pressures indefinitely. Ask for Trane Bulletin No. 152.

Heating Specialties



Trane Hermetic Valves—an outstanding example of Trane Heating Specialties—are packless in every sense of the word. Careful design has eliminated all Gaskets, Stuffing Boxes and Packing. Less than one turn is required for full opening. Easy modulation.

Trane Heating Specialties are indispensible in steam heating applications. They consist of a complete line of Traps, Valves, Vents, and Boiler Specialties, incorporating the famous Trane Balanced Pressure bellows. Ask for Trane Bulletins.

THE TRANE COMPANY, LA CROSSE, WIS.

TRANE CO[illegible] OF CANADA, LTD., TORONTO, ONT.

TRANE AIR^{n}

HEATING AND AIR CONDITIONING TO THE n^{th} DEGREE

CONDITIONING EQUIPMENT

Address The Trane Company, 2004 Cameron Avenue, La Crosse, Wis.

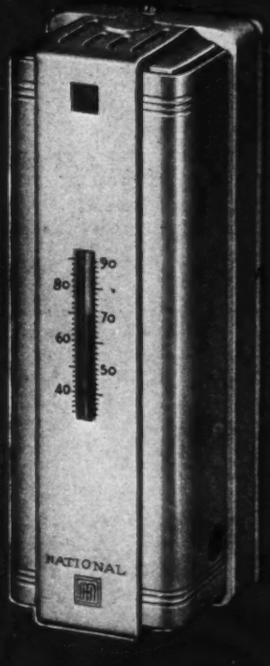
TUBE-TURNS* LEAD THE WORLD!

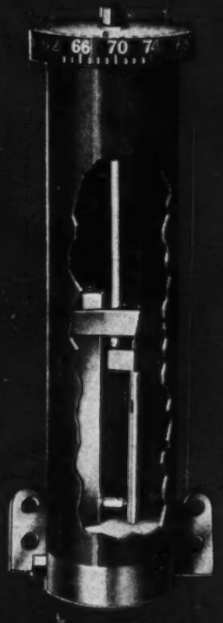
The advantages and economies of Tube-Turns and welding are so great that it takes thirteen full pages to describe them all (see Bulletin 107). *But a simpler way to state these facts is merely this: More engineers specify Tube-Turns than any other welding fitting in the world . . .* Tube-Turns alone give you truly uniform wall-thickness at all points—maximum strength—minimum weight—optimum flow characteristics. May we *prove* these points to you? Address: Tube-Turns, *Incorporated,* Louisville, Ky.

*The word "Tube-Turn" is NOT a necessary general trade name for welding fittings. It is the registered trade-mark for the products made by Tube-Turns, Incorporated, under their patents.

Only NATIONAL GIVES YOU HELMET SEAL PROTECTION

ONLY in a National Pneumatic Control System can you get the complete protection afforded by a diver's helmet. The National Ebonite thermostatic element actually encloses the working parts—provides true Helmet Seal protection, while the air valve itself, with its over-size orifice is self seating and always clean. Helmet Seal gives you complete protection against chalk dust, air particles and chemicals and makes the National Pneumatic Thermostat jamproof. Only clean, filtered air enters the sealed chamber. In addition to Helmet Seal protection, only National can offer long life Metaphram valves and motors, an exclusive feature of this Pneumatic system. Backed as it is by the nation wide service organization of Minneapolis-Honeywell, National Pneumatic Control leads its field. Get the proved advantages of Helmet Seal protection and the Metaphram principle and insist on a National Pneumatic Control System. National Regulator Company division, Minneapolis-Honeywell Regulator Company, 2701 Fourth Avenue South, Minneapolis, Minnesota. Branches everywhere.





HELMETED PROTECTION

The National thermostatic element, a cylindrical tube of Ebonite, actually seals the working parts, and offers positive protection against any tampering.

MODERN APPEARANCE MODERN PERFORMANCE

The National Pneumatic Thermostat is as modern in its appearance as it is in its performance. It is simple and durable, and its Ebonite element, which has proved itself for more than 35 years, makes it extremely accurate.

NATIONAL PNEUMATIC *Control Systems*

A Product of

MINNEAPOLIS-HONEYWELL REGULATOR CO.

Improved FAFNIR RUBBER PILLOW BLOCKS

First – SILENCE

That the Fafnir Rubber Pillow Block met an urgent need of air conditioning and ventilating equipment manufactures for a *silent* bearing is proved by its wide use. This time-tested Fafnir Ball Bearing floating in molded rubber provides elimination of bearing noise from fan and blower rotors and pump shafts. The resiliency of the rubber mounting compensates for misalignment or slight longitudinal shaft expansion.

Now-UNEQUALLED EASE OF INSTALLATION

Now the Fafnir Rubber Pillow Block is offered with the exclusive self-locking collar. Provided in no other bearing, it gives Fafnir the advantage of easy installation, a positive lock on the shaft, greater shaft support, easy removal.

Each bearing is packed with sufficient grease to last for years. Integral plate shields seal out dirt. Supplied with lubricant fitting if desired, for extreme conditions. Made in sizes to fit shafts from ½″ to 1 7/16″ diameter. For complete details on this exclusive Fafnir development write for Bulletin RS. The Fafnir Bearing Company, New Britain, Conn. Branch offices: Atlanta, Chicago, Cleveland, Dallas, Denver, Detroit, Kansas City, Los Angeles, New York, Philadelphia, Seattle.

EASY AS 1–2–3 TO INSTALL

1. *Slip the shaft through the bearing unit . . .*

2. *Engage and turn the collar . . .*

3. *Set the screw . . . and the bearing is secured to the shaft.*

FAFNIR BALL BEARINGS

THE BALANCED LINE—MOST COMPLETE IN AMERICA

NOTHING ELSE.

to Buy!

See The Fulton Sylphon Co. Exhibit—Booths 252-253 at the Fifth International Heating & Ventilating Exposition, New York, January 24 to 28, 1938.

When you select Sylphon Temperature Regulators—*there is nothing else to buy.* These self-contained, self-powered, self-sufficient control units are entirely independent of outside sources of power — need no auxiliary equipment, compressors, high pressure piping, wiring, switches, motors or relays for operation. They are installed in a few minutes.

Regulator illustrated is the Sylphon No. 931—practically the "Standard" for control of hot water Storage Tank temperatures.

Thousands are in use. Many installed more than twenty years ago are today performing just as efficiently as when new—proof of their lasting satisfaction.

Write for an experienced sales engineer to call and suggest the Sylphon instruments designed for your control needs whether for space heating, service hot water, refrigeration, or industrial processing. Or ask for Bulletin XE-20.

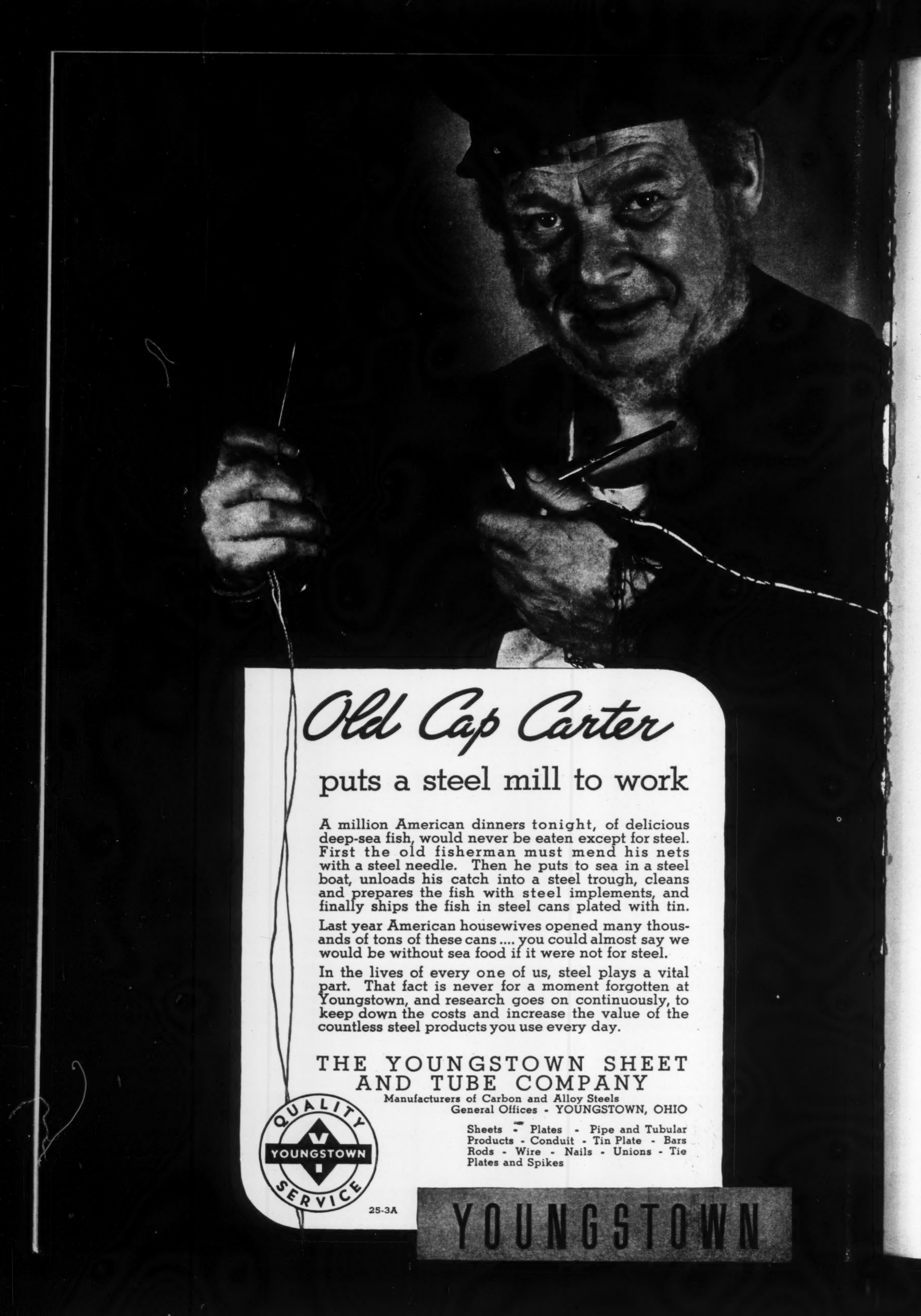
THE FULTON SYLPHON CO.

KNOXVILLE, TENNESSEE

Representatives in All Principal Cities in U. S. A. and in Montreal, Canada and London, England

SYLPHON *Control*

"POWERED BY THE TEMPERATURE IT REGULATES"



Old Cap Carter

puts a steel mill to work

A million American dinners tonight, of delicious deep-sea fish, would never be eaten except for steel. First the old fisherman must mend his nets with a steel needle. Then he puts to sea in a steel boat, unloads his catch into a steel trough, cleans and prepares the fish with steel implements, and finally ships the fish in steel cans plated with tin.

Last year American housewives opened many thousands of tons of these cans .... you could almost say we would be without sea food if it were not for steel.

In the lives of every one of us, steel plays a vital part. That fact is never for a moment forgotten at Youngstown, and research goes on continuously, to keep down the costs and increase the value of the countless steel products you use every day.

THE YOUNGSTOWN SHEET AND TUBE COMPANY

Manufacturers of Carbon and Alloy Steels
General Offices - YOUNGSTOWN, OHIO

Sheets - Plates - Pipe and Tubular Products - Conduit - Tin Plate - Bars Rods - Wire - Nails - Unions - Tie Plates and Spikes

QUALITY YOUNGSTOWN SERVICE

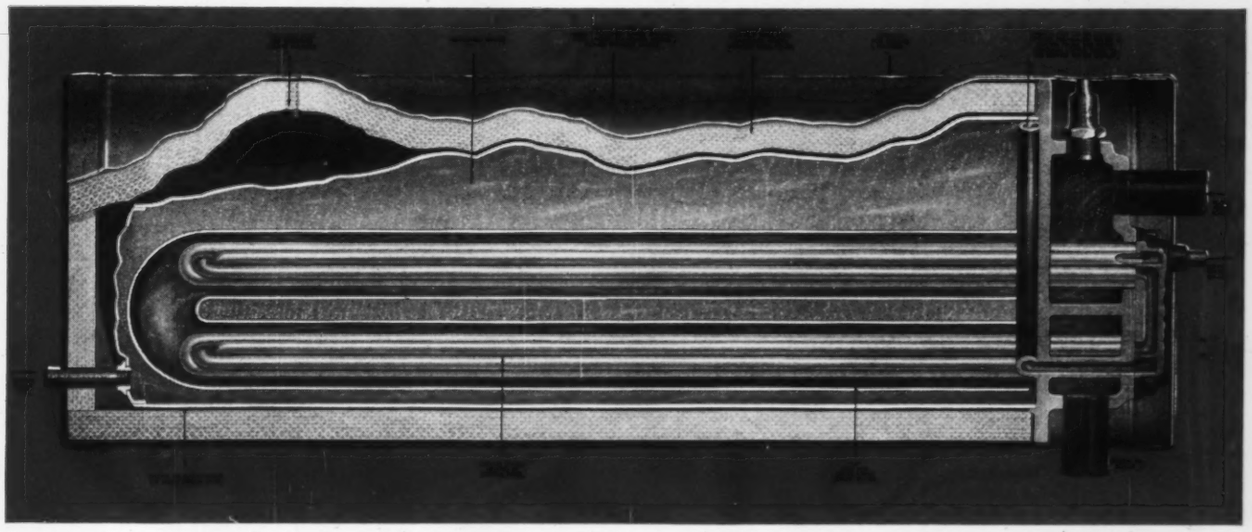
25-3A

YOUNGSTOWN

...AND NOW THE

THERMO-VOIR

A WATER HEATER SO REVOLUTIONARY IN DESIGN THAT AN ENTIRELY NEW STANDARD OF ECONOMY IS ESTABLISHED . . . FOR THE FIRST TIME PROVIDING A MEANS OF UTILIZING THE STAND-BY HEAT LOSS OF THE BOILER . . . FURNISHING A VIRTUALLY UNLIMITED SUPPLY OF HOT WATER AT THE LOWEST COST EVER POSSIBLE!



Forget all your present ideas of water-heater efficiency! Because here is a unit which employs an utterly different principle to achieve an unheard-of economy. The B & G Thermo-voir literally "Soaks up Heat" from the boiler . . . so effectively that it can be used even with new-type boilers having small water content and large heat absorption.

The B & G Thermo-voir is adaptable to both hot water and steam boilers and is offered in non-ferrous metals in the DeLuxe model, galvanized metal in the Standard model. It's light in weight, compact, smartly modern in appearance and installed with a minimum of labor. Don't wait—send the coupon at once for complete details on installation and operation.

BELL & GOSSETT CO. **B&G** **CHICAGO**
3000 Wallace St.

BELL & GOSSETT CO.
3000 Wallace St., Chicago
Send me complete information on the B&G Thermo-voir.

Name .....
Address .....
City ..... *State* .....

. . . and then they* put in ARMSTRONG Steam Traps:

20 days of pipe maintenance a month!

BEFORE						
..	..	~~1~~	~~2~~	~~3~~	~~4~~	~~5~~
6	~~7~~	~~8~~	~~9~~	~~10~~	~~11~~	~~12~~
13	~~14~~	~~15~~	~~16~~	~~17~~	18	19
20	~~21~~	~~22~~	~~23~~	~~24~~	25	26
27	~~28~~	29	30	..	..	..

AFTER						
..	..	1	2	3	4	5
6	7	8	9	10	11	12
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27	28	29	30	31	..	..

***R. Thomas & Sons Co., Lisbon, Ohio**

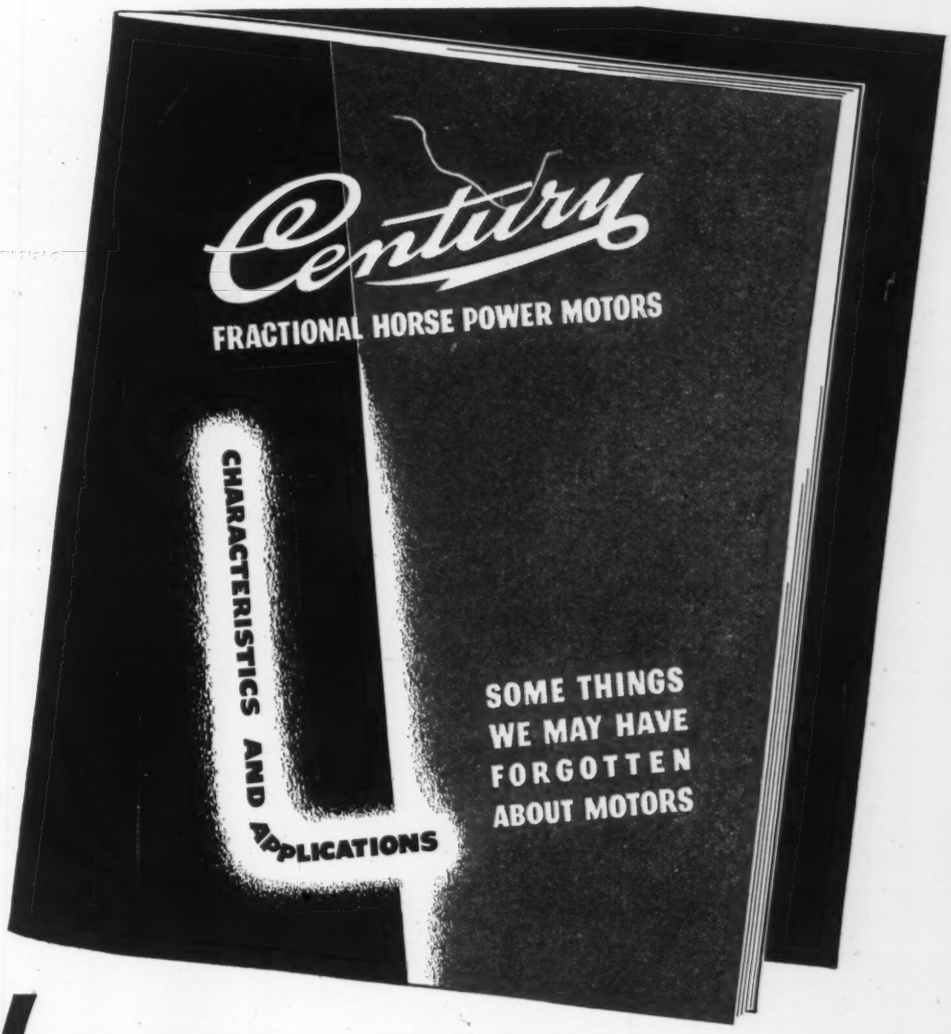
WHAT happens when you put in individual Armstrong Steam Traps throughout a plant is strikingly demonstrated by the recent experience of R. Thomas & Sons Co. This manufacturer was using two tilt type traps to drain a big 100-car drier used in the production of fine porcelain insulators. Results were very unsatisfactory. Water and air pockets formed in the drier coils and heating was spotty. One maintenance man spent twenty days of his time each month working on piping, traps, etc.—particularly on the drier.

Then A. E. Kauffman, maintenance manager of the plant, put in 66 Armstrong traps—32 on the drier. Fuel consumption dropped from 5000 to 3000 lbs. per day. Heating is fast and even. Only two boilers are required where three were needed before. And the maintenance man now averages only one day a month on piping for the entire plant.

* * * * * * * * *

Armstrong traps are made FOR MEN TOO BUSY TO FOOL WITH TRAPS. Give them a test. *Ask about our 90 day free trial offer.*

ARMSTRONG MACHINE WORKS
874 Maple Street **Three Rivers, Michigan**


Century
FRACTIONAL HORSE POWER MOTORS
CHARACTERISTICS AND APPLICATIONS
SOME THINGS WE MAY HAVE FORGOTTEN ABOUT MOTORS

THIS BOOK *tells..*

HOW *to* SELECT *the* RIGHT MOTOR

This New 24-page book will be of real assistance to you . . . Here is presented in helpful form information concerning the electrical characteristics of all types of Fractional Horse Power Motors—and suggestions as to how they can be most effectively applied to meet the requirements of motor-driven machinery and appliances operating in normal or abnormal surroundings . . . Fully illustrated . . . Send for your copy, if you have not received it . . . **ASK FOR BULLETIN 1039-M . . .**

CENTURY ELECTRIC COMPANY

1806 Pine Street . . . . . St. Louis, Mo.

Offices and Stock Points in Principal Cities

Century MOTORS

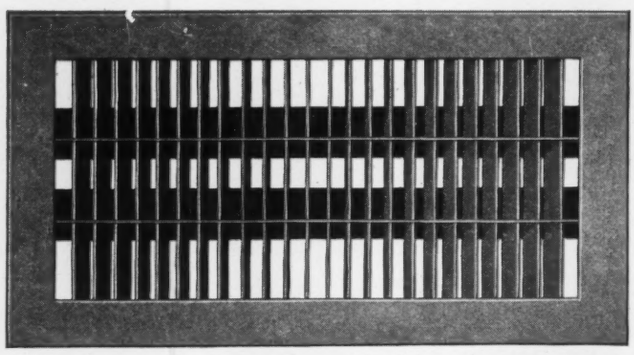
UP TO 600 HORSE POWER

INDEPENDENT "FABRIKATED" *Adjustable*
DIRECTED AIR FLOW REGISTERS AND GRILLES

with deflecting vanes give

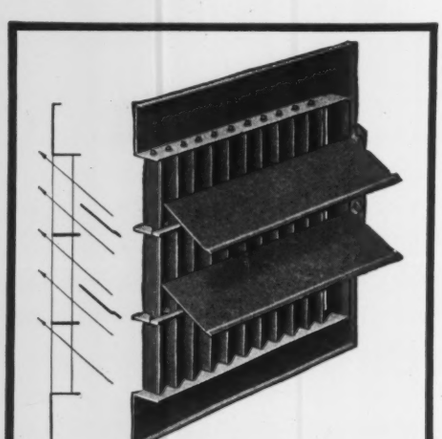
FOUR-WAY DIRECTION TO AIR FLOWS

Deflecting Vanes direct air flows up or down.



Vertical Grille Bars deflect air flows to right or left

Each grille bar is adjusted individually



Rear view showing Deflecting Vanes

• Deflections of air flows which hitherto have been impossible are readily effected with this No. 321-A Independent "Fabrikated" Register with Deflecting Vanes. Horizontal deflection of air, right, left or fanwise, is imparted by the grille bars. Deflecting vanes back of the grille bars add a vertical deflection, up or down. With this register or grille, compound deflections of air flows can be achieved with accuracy and certainty.

Each vertical grille bar, likewise each deflecting vane in the back of the register, is adjusted individually with a special two-prong tool which accompanies each register.

Adjustment can be made after the register or grille is installed without taking it down. Grille bars and deflecting vanes do not require locking. They are held firmly in place, and can not be adjusted without the special two-prong tool, nor will they vibrate nor rattle.

Independent "Fabrikated" Adjustable Directed Air Flow Registers and Grilles are also made with horizontal grille bars and vertical deflecting vanes. Both types are available in any size. They fulfill every requirement for strength, rigidity, appearance and range of directed air flows.

Send for catalog and data book

THE INDEPENDENT REGISTER CO.

3757 EAST 93rd STREET • CLEVELAND, OHIO

Symbol

For countless ages, the Christmas tree has symbolized the gayety and good will of the yuletide. For many years also, the Delco name-plate on an appliance motor has signified long life, dependability and intrinsic *quality*. The prestige enjoyed by this symbol is reflected in the widespread public acceptance of Delco-powered washers, ironers, refrigerators, air conditioners, oil burners and stokers. Delco Products Division, General Motors Corporation, Dayton, Ohio. In Canada: McKinnon Industries, Ltd., St. Catharines, Ont.

DELCO MOTORS

● Away back underneath the popular success of Dole Valves is one little "difference" about them—a simple thing that may explain why it pays so well to carry them.

As a line, Dole Valves were designed from the start *both to serve and to sell.*

Hundreds of items do a good enough job once they get *on the job,* but nothing constructive has been done to make the selling easier for the dealer*.

Still other products have the flash that sells, but not the underlying quality that delivers real performance.

BUT . . . from BOTH the merchandising and the mechanical standpoint, the Dole Valve Company *insists on plus values* at every stage of design, engineering, purchase of materials, fabrication, plating, packaging, advertising, sales policy, jobber-dealer profit-margins and delivery . . . Right down the line.

They can't miss. They must not miss. That's company policy.

Ask a jobber or dealer what line of valves sells strongest and stays sold longest. It is Dole.

Because, they are right! . . . because they MUST be right.

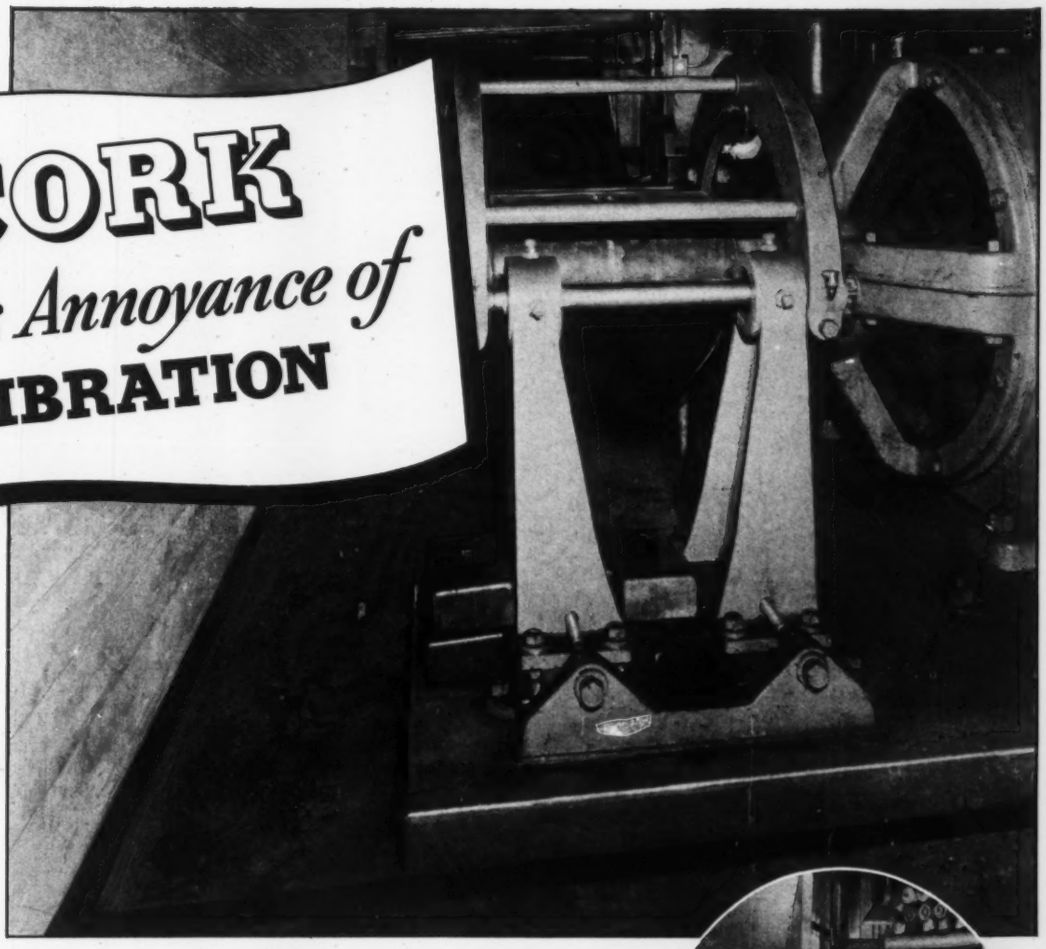
THE DOLE VALVE COMPANY
1901-1941 Carroll Avenue, Chicago, Illinois

DOLE

AIR AND VACUUM VALVES

Dole The Line of Least Sales Resistance

*In addition to the attraction of brilliant prize-winning packaging Dole Valves are regularly advertised to more than a million and a half home owners and large users.



CORK *Ends Annoyance of* VIBRATION

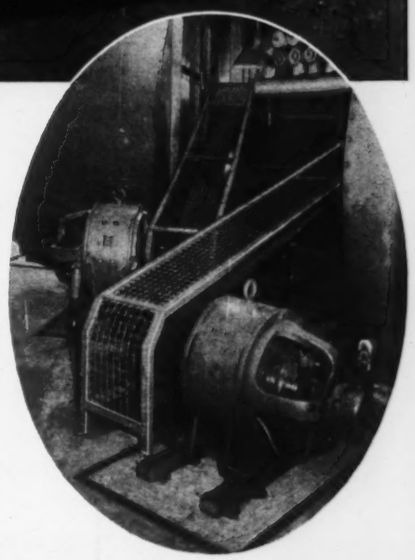
Resilient Armstrong's VIBRACORK *Quiets air conditioning machinery*

THE time to fight vibration trouble is when machinery is installed. And the way to end this nuisance permanently is with cork. Specify a cushion of Armstrong's Vibracork, and escape the unpleasant—sometimes even costly—consequences of the transmission of vibration!

You can build lasting quiet into all kinds of air conditioning installations with Armstrong's Vibracork. This pure cork cushion absorbs the vibration, and lessens the transmission of noise from any machine, large or small. Even whole floors of buildings may be isolated with Vibracork.

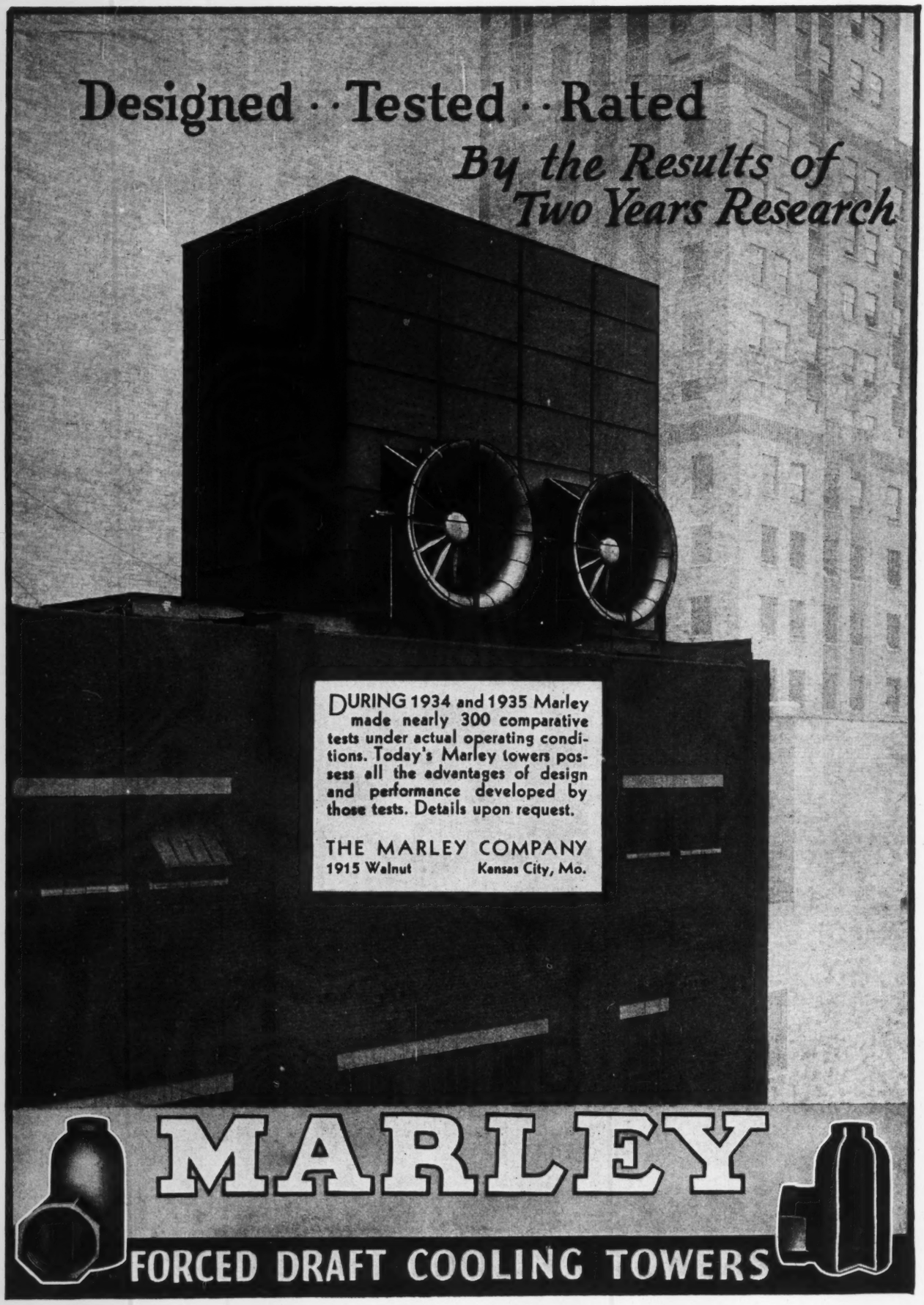
Because it is a manufactured product, Armstrong's Vibracork can be made in controlled densities to fit the job it has to do. It is composed of granules of pure cork, compressed and baked into boards of convenient and practical size. Properly installed and loaded within the correct weight limits, Vibracork does not take a "set," or lose its "life" in service.

Let Armstrong engineers work with you in planning vibration-quieted installations. Their wide experience can be of help in selecting the proper method of application, the right amount and density of Vibracork to use. And their advice is available without cost or obligation.



FREE BOOK SHOWS HOW TO USE VIBRACORK. Armstrong has prepared a 12-page book, profusely illustrated with photographs and diagrams, showing various methods of lessening the transmission of vibration. A copy will be sent you free on request. Write to Armstrong Cork Products Company, Building Materials Division, 994 Concord Street, Lancaster, Pennsylvania.

Armstrong's VIBRACORK


Designed · · Tested · · Rated
By the Results of
Two Years Research
DURING 1934 and 1935 Marley made nearly 300 comparative tests under actual operating conditions. Today's Marley towers possess all the advantages of design and performance developed by those tests. Details upon request.
THE MARLEY COMPANY
1915 Walnut Kansas City, Mo.
MARLEY
FORCED DRAFT COOLING TOWERS

IMPREGNABLE!

In the Allis-Chalmers Seal-Clad Motor the w[illegible] and stator rec[illegible]ves impreg-
nating treatment, similar to the conventio[illegible] type of wind[illegible]ng. Then a
Moulded Shield of high dielectric and mech[illegible]nical strength [illegible]s fitted into
a machined slot in the stator frame and tigh[illegible]y sealed into p[illegible]osition with
a special compound—thus giving complete [illegible]protection to th[illegible] coils.
This feature makes Allis-Chalmers Seal-[illegible]Clad Motors im[illegible]regnable to
metallic dust, grit, oil, moisture, chemicals [illegible]and other agents [illegible]destructive
to motor windings.

One or more of these destructive agents [illegible]are present in ev[illegible]ry plant, to
a greater or lesser degree . . . so why take a [illegible]chance?

If your plant conditions are severe, the ul[illegible]mate in motor [illegible]rotection is
essential to you—Allis-Chalmers Seal-Clad [illegible]Motors offer th[illegible] ultimate in
motor protection. If your plant conditions are [illegible]not so severe as [illegible]to make this
protection absolutely essential, Allis-Chalm[illegible]ers Seal-Clad M[illegible]otors are still
the soundest investment you can make, BE[illegible]CAUSE YOU [illegible]RE GIVEN
THIS GREAT ADDITIONAL PROTECTI[illegible]ON AT NO A[illegible]DDITIONAL
COST.

For further details, write today for Leaflet [illegible]No. 2182.

The Allis-Chalmers Mfg. Co. builds standard motors of every type from 1 hp. up—also motors for special application.

795

MOTOR DIVISION

ALLIS·CHALMERS

MILWAUKEE WISCONSIN

This Advertisement Was Written by an Air Conditioning Manufacturer . . .*

IN response to our campaign for better filters, a manufacturer of air conditioning equipment writes: "The cost of cleaning air, that is, the cost to the user of air conditioning equipment, can very easily become the big stumbling block in the future sale of air conditioning. In an attempt to save on cleaning costs users often remove filters after they have become loaded with dirt, thus allowing the coil of the conditioner to become so loaded with lint and foreign matter that the efficiency of the installation is reduced to a fraction of its normal capacity. Just the other day, because of this practice, the work of two men for four hours was required to clean up the coil of a conditioner which was much more than the cost of new throw away type filters and many times more than the cost of cleaning permanent type filters."

Every air conditioning manufacturer has had similar trouble. In some cases the air conditioning system starts out handicapped with reduced air volume due to the filters being loaded with construction dirt. With permanent filters it is a simple and inexpensive operation to clean the filters and to maintain the satisfactory performance of the system at all times.

The difference between a disgruntled and a satisfied customer, or a satisfactory and "lemon" installation might easily justify the extra initial cost of permanent filters to manufacturer or distributor.

The cost of clean air equals the initial filter cost plus expense of maintenance. Permanent washable filters have proved their overall economy and are now specified by some of the country's largest users of air conditioning equipment. Still further proof of their superiority has been established by a list of 32 leading American railroads which are using them in some 7000 air conditioned cars.

The American Air Filter Co. has pioneered the development of permanent filter equipment to meet every air conditioning requirement. Write us for information on the type of permanent filter best suited to use on the air conditioning equipment which you manufacture.

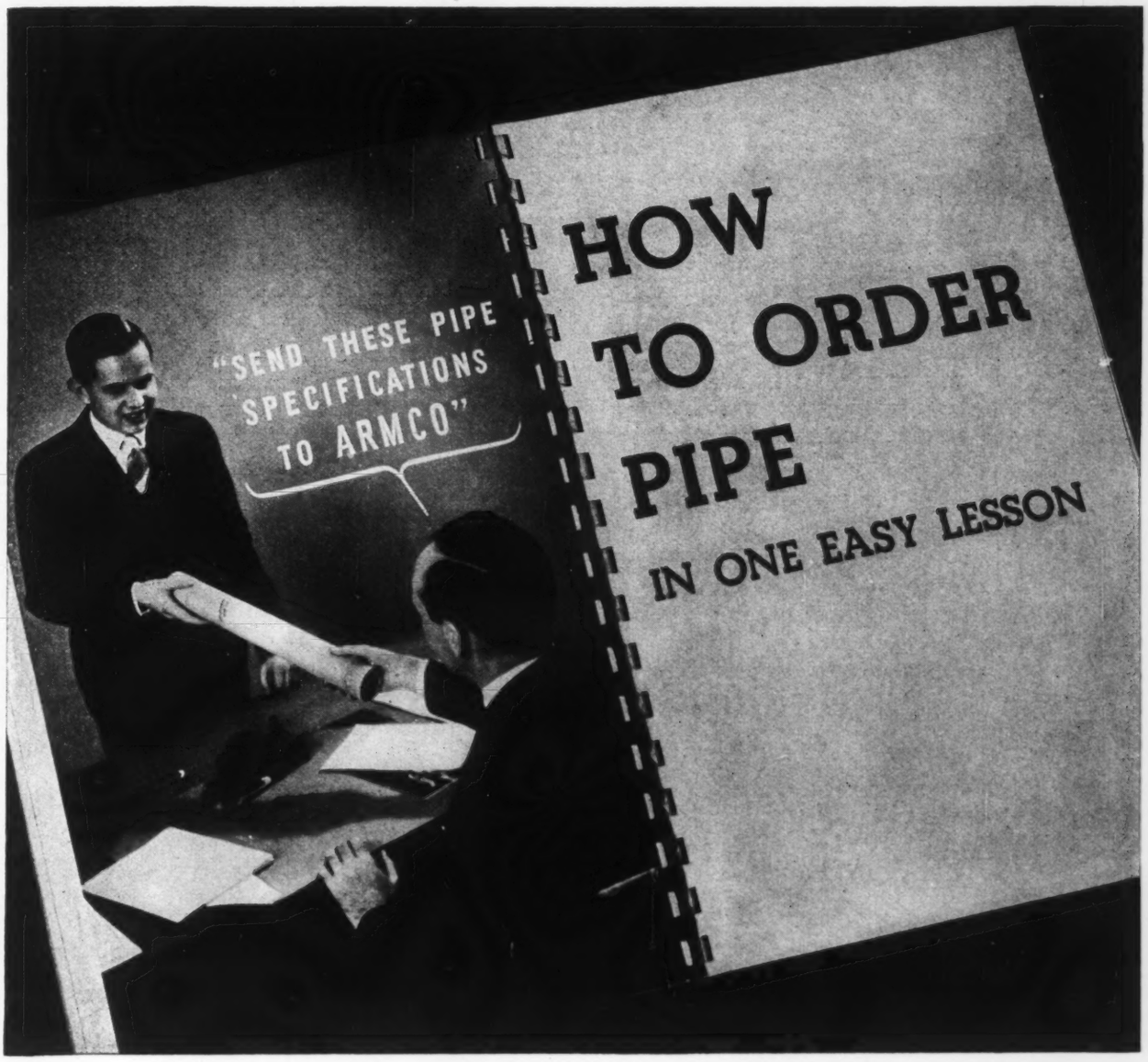
AMERICAN AIR FILTER CO., INC.

INCORPORATED

107 Central Ave., Louisville, Ky.

In Canada: Darling Bros., Ltd., Montreal, P. Q.

*name on request.



A few lengths or several miles—it makes no difference. You simply mail your plans and specifications and we "tailor" Armco Spiral Welded Pipe to fit *your individual requirements*, including standard or special connections.

This way you save time, save money. And best of all, you are sure to be well pleased with Armco "Spiral Welded." Being free of excess weight, it is easy to handle and install. Yet it's amply strong and ductile, for virtually any kind of line—water, oil, gas or low pressure steam.

Mail your plans and specifications today for diameters 6 to 36 inches; wall thicknesses 7/64 to ½ inch; lengths up to 40 feet. Specify durable ARMCO Ingot Iron or steel—also your favorite protective coating, including galvanized after fabrication. The American Rolling Mill Co., Pipe Sales Division, 806 Curtis St., Middletown, Ohio.

Radio Announcement • Beginning January 2, listen to the Armco radio program Sunday afternoons at 3:30 P.M. (Eastern Standard Time) over N.B.C. Blue network.

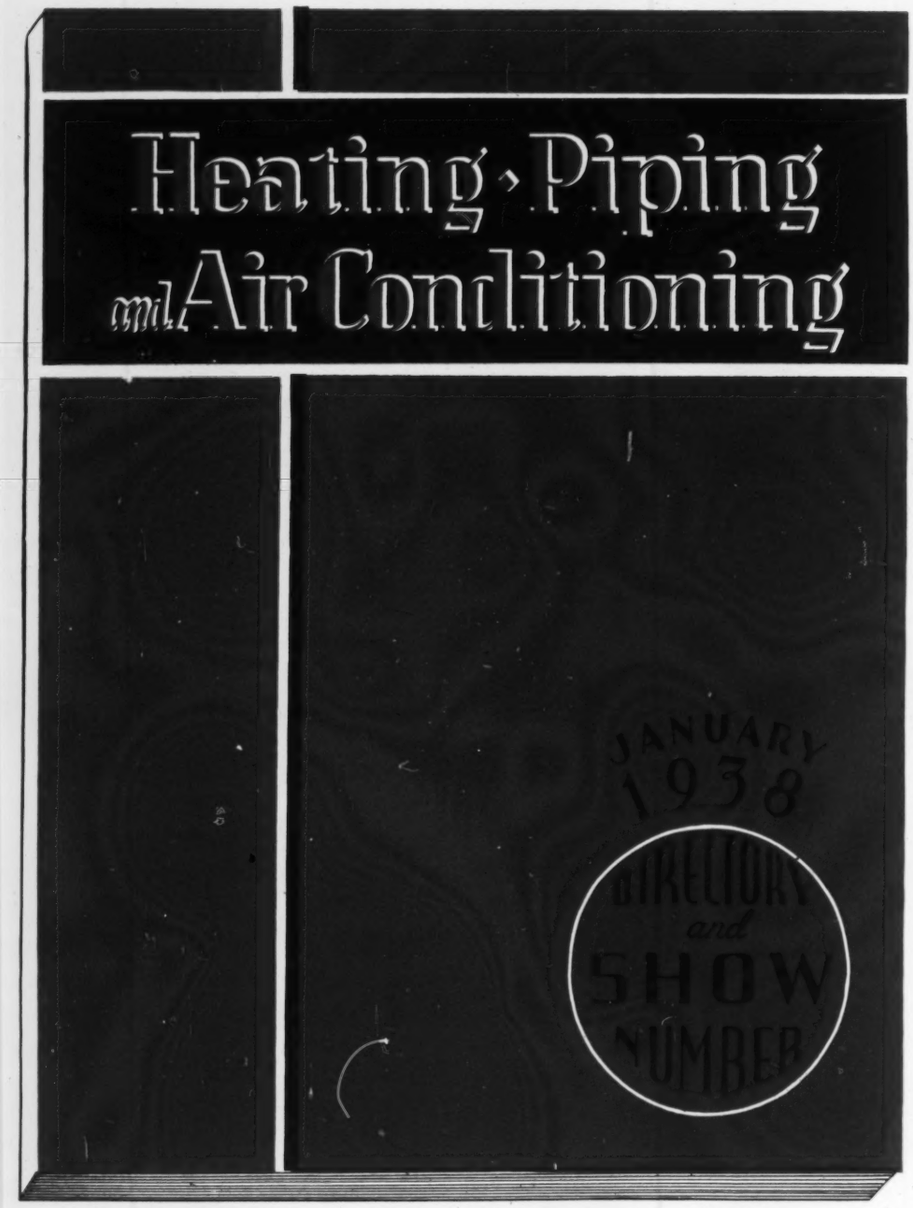
ARMCO

ARMCO SPIRAL WELDED PIPE

The Next Issue is IT!

The January 1938 DIRECTORY and SHOW NUMBER

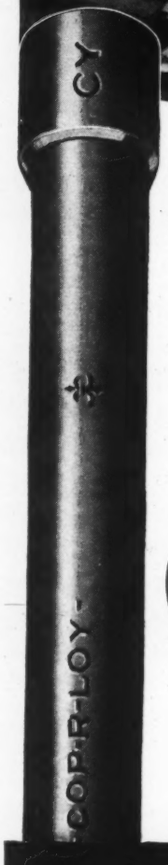
IN YOUR HANDS EARLY IN JANUARY



MANUFACTURERS:

There is still time to arrange for a complete showing of your line in this issue —always the outstanding advertising buy of the year. The January 1938 Directory and Show Number will work for you *before* the Show, *during* the Show, and for eleven months *after* the Show. No increase in rates. Write or wire for complete details today.

What Kind? What Size? A LENGTH OR A CARLOAD?



WHEELING STEEL

YOUR DISTRIBUTOR *HAS IT* . . . . .

With complete stocks carried by leading distributors throughout America, you can depend upon prompt delivery of Wheeling COP-R-LOY Pipe for every type of project. Where conditions are unusually severe, where dependable, economical performance is essential, and where low cost is an important consideration, you can safely specify COP-R-LOY Pipe. It has written its own record for durability. Order COP-R-LOY tubular goods by name . . . It's Wheeling Steel. Wheeling Steel Corporation, Wheeling, West Virginia.

Whitaker Range Boilers and Special Tanks, made of COP-R-LOY, are available through your regular source of supply.

COP-R-LOY *Pipe*

Reg. U. S. Pat. Off.

IT'S WHEELING STEEL

NOW FOR EITHER . . . . . LINE OR LOW VOLTAGE

"GENUINE DETROIT" THERMOSTATS

No. 211 for Low Voltage
No. 311 for Line Voltage

Straight line temperature control, eliminating "cold 70"

Applicable to both heating and cooling

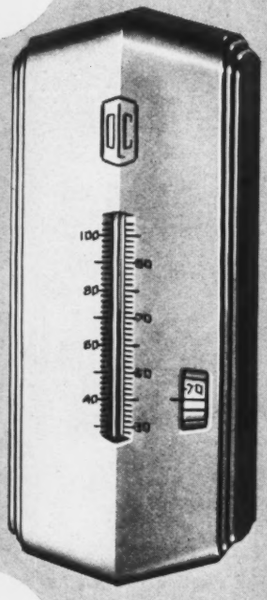
With or without heat compensation

For use on two- or three-wire circuits, low voltage only

Varying electrical load has no effect on compensator

Heating cycle readily adjustable over wide range

Available also in summer and winter, or day and night types, in low voltage only



"GENUINE DETROIT" HUMIDISTATS

No. 197 for Low Voltage
No. 397 for Line Voltage

Incorporates extremely sensitive Friez hair element

Accurate up to 100% relative humidity

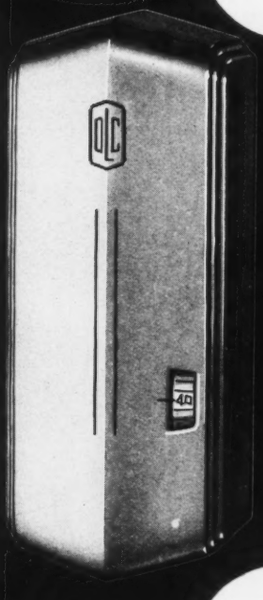
Controls either humidification or dehumidification

No flutter nor danger of corrosion of contacts

Both instruments attractively styled for modern interiors

Low voltage Humidistat and Thermostat carried on an attractive dual mounting plate if desired

Not vulnerable to dust accumulation

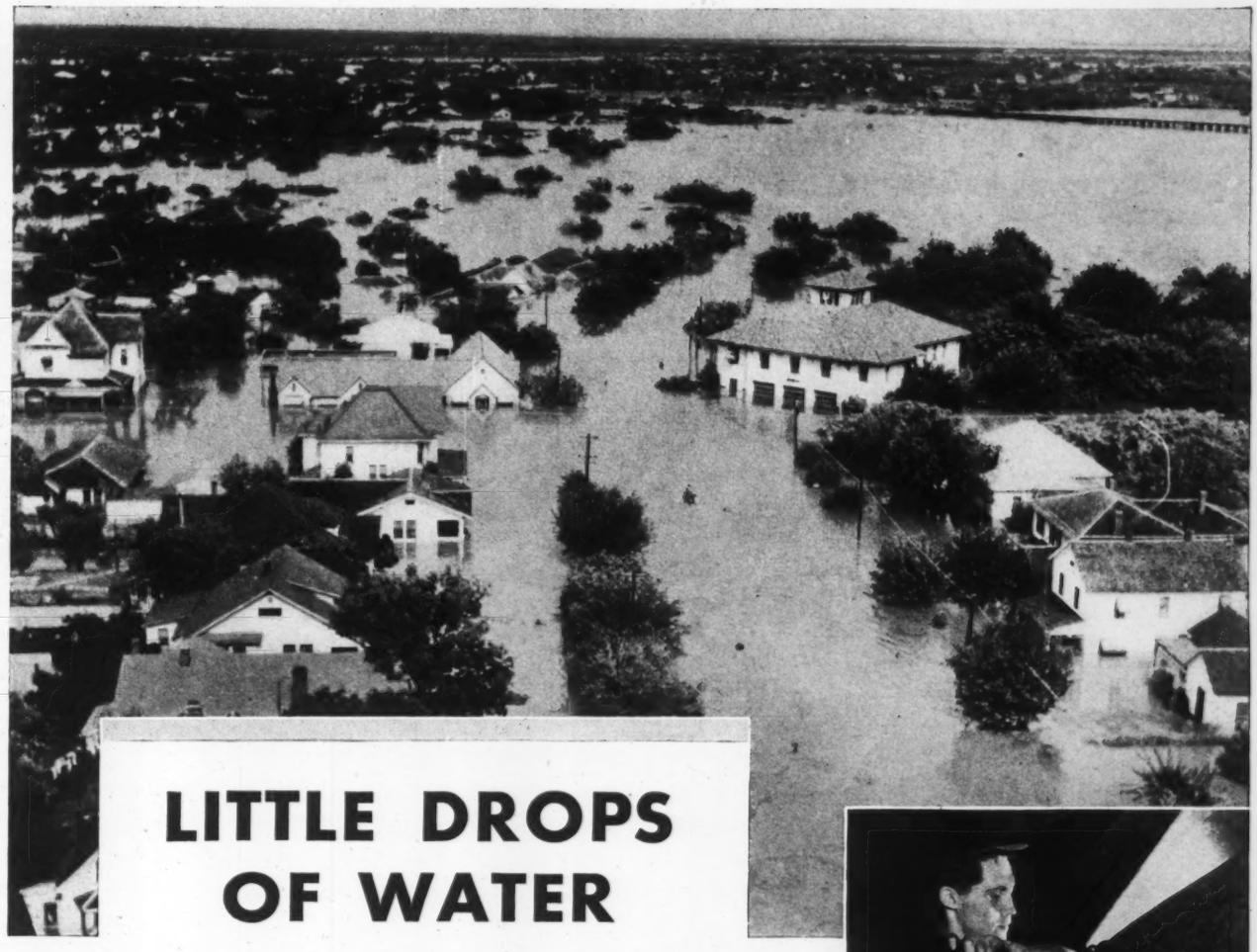


ALL THESE ADVANTAGES AT NO EXTRA COST

RATINGS . . .

Electrical Load Ratings—
No. 211 and No. 197 for low voltage: 25 watts at 25 volts—A. C. or D. C. • No. 311 Thermostat for line voltage: ¼ hp R. I. motors at 110 volts A. C. • No. 397 Humidistat for line voltage: 50 watts at 110 volts A. C. or D. C.

DETROIT LUBRICATOR COMPANY
DETROIT, MICHIGAN, U. S. A. • 5900 TRUMBULL AVE.
NEW YORK, N. Y.—40 WEST 40th ST. • CHICAGO, ILL.—816 S. Michigan Ave.
DIVISION OF AMERICAN RADIATOR & STANDARD SANITARY CORPORATION
Canadian Representative—RAILWAY AND ENGINEERING SPECIALTIES LIMITED, Montreal, Toronto, Winnipeg



LITTLE DROPS OF WATER

can make oceans of trouble for air conditioning equipment, too!

U·S·S *Copper Steel Galvanized Sheets have double the atmospheric corrosion resistance of plain galvanized sheets and cost but little more.*

MILLIONS of tiny particles of moisture continually bombard the walls of air conditioning equipment. They seek out any weak spot and attack it with all the forces of corrosion. It takes steel with a double line of defense to withstand this onslaught for long periods of time.

Metallurgists have found that a proper percentage of copper in the steel, plus good galvanizing, more than doubles its resistance to atmospheric corrosion. The value of the increased life of ducts, grills, fans, housings and other exposed equipment, due to the addition of copper, is far greater than its slightly higher cost.

Here's an important advantage you can't afford to overlook—the immediate savings possible due to the *splendid workability* of U·S·S Copper Steel Galvanized Sheets. Use them on your most severe forming jobs—they can be bent, rolled, cut and soldered readily. This means real savings to the fabricator and building owner.

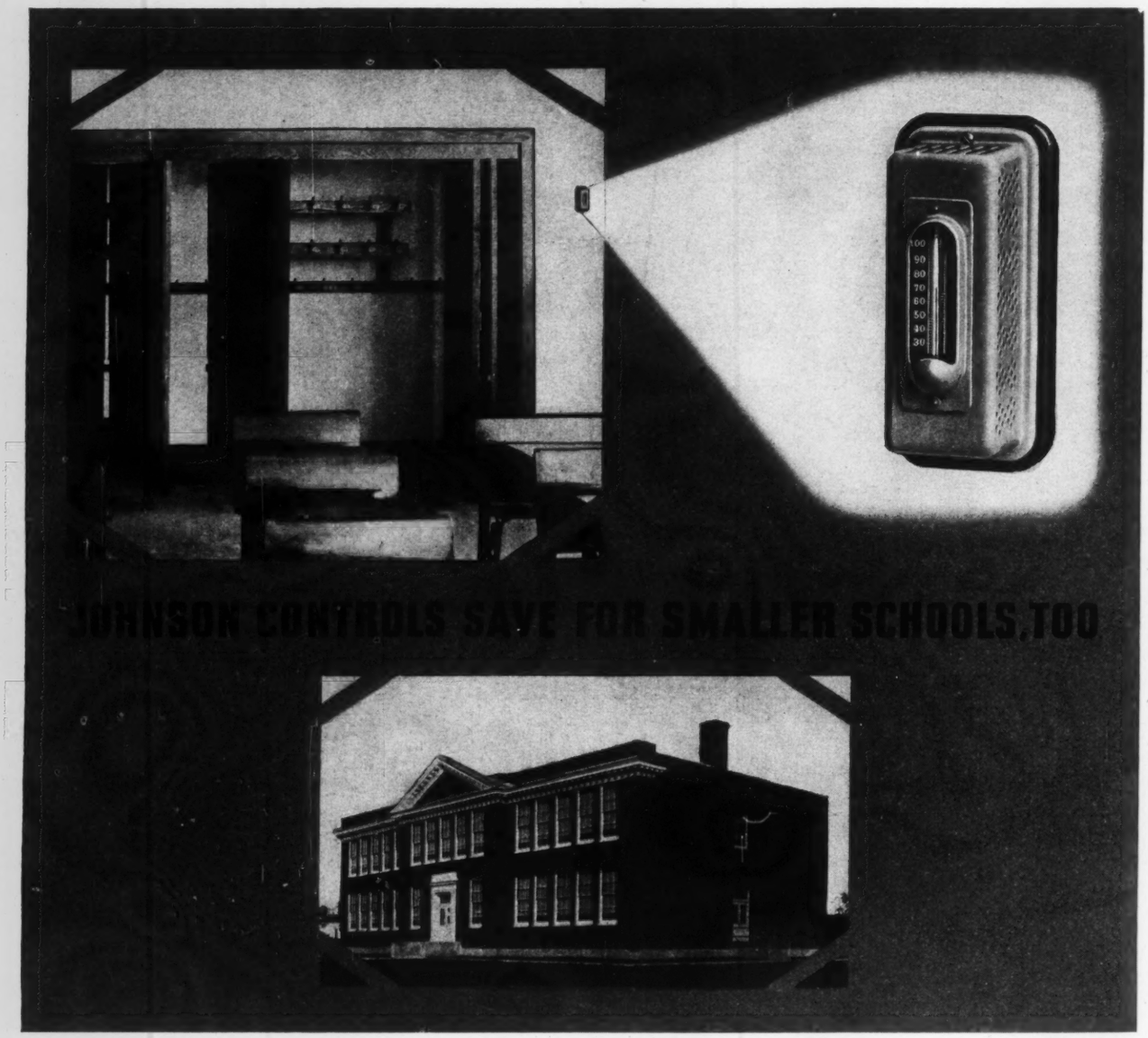
In addition to copper steel sheets, we offer a complete line of plain galvanized and black sheets for less corrosive conditions. Sold by leading metal merchants. Write or call our nearest sales office.

U·S·S COPPER STEEL GALVANIZED SHEETS

CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
TENNESSEE COAL, IRON and RAILROAD COMPANY, *Birmingham*

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL



George Washington Feaser Grade School, Middletown, Pa.
John H. Wickersham, architect, Lancaster, Pa.; C. C. Kottcamp & Son, mechanical contractors, York, Pa.

FUEL BILLS REDUCED!—Energy of teachers and pupils conserved! Enthusiastic reports from school administrators, representing all sizes of schools, repeatedly endorse the accurate automatic control of temperatures by Johnson systems. The smaller school must carry on a "cost reducing program," as well as the large metropolitan school. There are Johnson control arrangements to fit every need and for every type of heating and ventilating system, large or small.

At Middletown, the eleven principal rooms are "Johnson controlled." A room thermostat in each room operates valves on direct radiators and valves and dampers in ventilating units . . . Johnson has applied its entire effort, for more than fifty years, to this one science. A nation-wide organization has been developed for the installation and service, as well as the manufacture, of the Johnson apparatus. It must be "exactly" right, all the way!

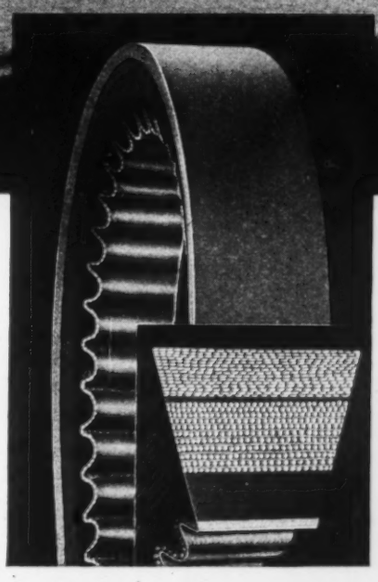
JOHNSON SERVICE COMPANY · · · MILWAUKEE, WISCONSIN
Branch offices in all principal cities

JOHNSON

AUTOMATIC TEMPERATURE AND HUMIDITY CONTROL

For Heating - Cooling - Ventilating & Air Conditioning Systems

No Other V-Belt compares with Dayton for SMOOTH RUNNING



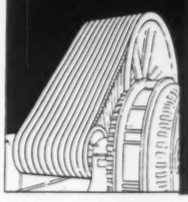
Gliding smoothly, quietly, and steadily from pulley to pulley . . . Dayton Cog-Belts transmit the full force of motive power without apparent effort.

They run straight and true. Their patented, exclusive construction gives them perfect accuracy and balance. With Dayton Cog-Belts there's no buckling, no squashing, no twisting in the pulley grooves . . . none of the weaving, writhing, whipping action which shatters the life out of other belts and racks machinery with vibration.

Dayton Cog-Belts require less maintenance and adjustment. They reduce trouble and expense. They keep machines going at rated speed and increase production. They work on shorter centers and save space. They last longer.

Write us for catalogs and data, or call your local Dayton Distributor.

THE DAYTON RUBBER MFG. CO.
DAYTON, OHIO



Dayton
COG-BELT DRIVES

PROFIT *by studying displays like these*

A few Exhibits at the 4th International Heating and Ventilating Exposition

ENGINEERS AND TECHNICAL MEN, concerned primarily with design and specifications . . . OPERATING MEN, PLANT MANAGERS and SUPERINTENDENTS, responsible for the proper functioning of equipment . . . EXECUTIVES, BUILDING MANAGERS AND CONTRACTORS—all interested in seeing the latest equipment designed to solve their particular problems are looking forward to an important forthcoming event—the Fifth International Heating and Ventilating—Air Conditioning—Exposition.

Thousands of men will welcome this timely opportunity of studying the impressive displays of 300 leading manufacturers—seeing demonstrations of equipment that will satisfy the present-day demands for better living and working conditions—meet the exacting requirements of industrial operations.

You and your associates should certainly attend—

FIFTH
INTERNATIONAL HEATING & VENTILATING EXPOSITION
GRAND CENTRAL PALACE
NEW YORK N.Y.
January 24-28-1938

Held under the auspices of American Society of Heating & Ventilating Engineers

The Air Conditioning Exposition

5th INTERNATIONAL HEATING & VENTILATING EXPOSITION

GRAND CENTRAL PALACE JANUARY 24-28, 1938 NEW YORK, N. Y.

Managed by International Exposition Company

7968

Permanently tight . . .

The third pipe from the bottom is part of a 4-inch hydraulic system carrying water at 3,500 pounds per square inch. Tightness under such service is consistently obtainable by oxy-acetylene welding.

WHEN a piping system is joined by oxy-acetylene welding, it has no leaky joints which require periodic tightening, calking or costly insulation replacements. In place of each joint is a weld—and a properly made weld is as dependable as the pipe base metal—as strong, as ductile and as corrosion-resistant. A welded piping system is compact and is devoid of all dead weight.

Linde engineers have cooperated in the design and installation of thousands of piping systems and can assist you in the welding on your projects from the first blueprints to the testing of the finished installation. Ask the nearest Linde office for full details and how you may obtain a copy of the 200-page book, "Design of Welded Piping." The Linde Air Products Company, Unit of Union Carbide and Carbon Corporation, New York and principal cities.

Everything for Oxy-Acetylene Welding and Cutting

LINDE OXYGEN • PREST-O-LITE ACETYLENE • OXWELD APPARATUS AND SUPPLIES FROM UCC LINDE UNION CARBIDE

THE COMMODORE
NEW YORK CITY

Comfort Conditioned BY DUNHAM

Sub atmospheric Steam

• • • MEETS THE CHANGING CONDITIONS OF WEATHER BY CONTINUOUSLY CIRCULATING STEAM AT TEMPERATURES CORRESPONDING TO THE VARIABLE RANGE OF PRESSURES ABOVE AND BELOW ATMOSPHERE

DUNHAM Differential HEATING

HEATING

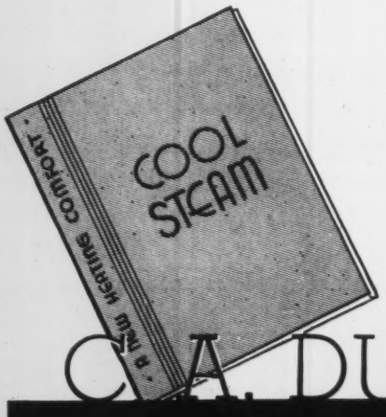
Through the silent circulation of steam, matched in temperature to precise weather requirements—Commodore guests . . . as do occupants of all Dunham "Comfort-Conditioned" buildings . . . enjoy ideal warmth no matter how widely or rapidly winter weather changes. They are comfortable in frigid "snaps" . . . equally comfortable in mild "spells" . . . and during mild periods they are never exposed to the stifling over-heating effect of "pressure" steam.

Dunham Sub-atmospheric Steam Heating—subject to manual control for the moderate size building, full-automatic for the larger project, contributes in addition to the tangible value of Comfort, an important financial aspect. For this system . . . in all weathers . . . without variance . . . performs at a hitherto unattainable degree of economy.

Many Vacuum Return line systems as was the Commodore have been Comfort-Conditioned by Dunham without replacement of steam source, piping or radiation.

May we send the interesting brochure "Cool Steam?"

Consult the Architect for good design and the Consulting Engineer for mechanical equipment.



C. A. DUNHAM COMPANY

450 EAST OHIO STREET, CHICAGO

Over 80 Sales Engineers in the United States, Canada and the United Kingdom bring "Dunham Heating Service" as close as your telephone. Consult your classified telephone directory for the address in your city.

5 TIMES A MINUTE

300 Times an Hour

OPEN, shut—open, shut. Ceaselessly, valves are opened and shut in a special "torture machine" at the Crane laboratories. Five times a minute . . . 300 times an hour . . . 2,400 times every eight-hour shift, until the stem gives up its life and the "post-mortem" adds to the vast body of Crane knowledge of valves.

Engineers tabulate the results and study the thread profiles and thread clearances of the valves when finally they are worn out. From this comes definite information showing how to make good valves better . . . and better valves the best for their type of service.

Crane has tested to destruction thousands of valves, seeking information with which to build still better valves. Crane meets the challenge of "new" valve problems with solutions based on 82 years of valve and piping experience. Look in your new Crane No. 52 Catalog for the details regarding 38,000 items, tested in the laboratory and proved on the job. Use it whenever you need valves, fittings, pipe or accessories. CranEquip for satisfaction.

CRANE

CRANE CO., GENERAL OFFICES: 836 S. MICHIGAN AVENUE, CHICAGO, ILL.

Branches and Sales Offices in One Hundred and Sixty Cities

VALVES, FITTINGS, FABRICATED PIPE, PUMPS, PLUMBING AND HEATING MATERIAL

plied in the next few days.

STICKING TO QUALITY SIMPLE SAFEGUARD, SAYS ENGINEER

NEW YORK CITY, Nov. 19.—"The power plant engineer who sticks to a policy of buying only quality products, whether large or small items, is the man who operates at lowest costs and with least trouble," said a power plant engineer here today.

"The original cost of a small valve is so little, or the leakage from one small valve may seem so small that it is easy to overlook the large losses over a year that come from replacing many small valves or having a large number of small leaks," he continued.

Crane has always recognized the importance of doing small things well. The testing of small valves to destruction in a machine that opens and shuts them continuously under service loads is one illustration of Crane care in providing highest quality at low cost in small valves.

The results of these tests are reflected in better threads, better stems, better body and seat materials. When next you need small valves, specify Crane. Check up, for example, on the number of spots where the Crane No. 7 line of valves can serve you. Sizes from ⅛ to 3 inches, globe and angle, screwed or flanged, Slip-On Disc Holder for quick and easy replacement, discs of various types for various services. See page 16 of your Crane No. 52 Catalog for details. CranEquip for piping satisfaction.

STOP WASTING MONEY THIS WAY

FAIRBANKS RENEWABLE IRON BODY GATE VALVES

One man handles the repairs on this valve—without removing body from pipe line

To put in a new ring, simply place it in the valve body so the lugs on ring fit into recesses in valve. A short turn locks it in place.

If you want to see where a nice little pile of money is wasted, watch men "fixing" leaky valves.

You will see that it takes *two* men to remove large valves from the pipe line. And you will note, in many instances, that they scrap these costly valves because they are non-renewable or hard to repair. Yet, the inexpensive seat is usually the only part worn.

But it is different with Fairbanks *Renewable* Valves. They're so simple to renew that it is far easier and quicker to replace worn seats or wedges than to rip out the old valve.

One man—instead of *two*—can insert new parts in less than five minutes without removing Fairbanks Valves from the line or disturbing the pipe coverings. Then the valves are as good as new. And you save the cost of one man's labor, as well as the price of new valves.

Every part of Fairbanks Renewable Valves subject to excessive wear can be renewed quickly at small cost. The parts never stick and have to be broken or injured when renewing.

Put Fairbanks "Renewables" to any test you like—and we know you will use them exclusively thereafter.

May we send you our Catalog No. 21?

THE FAIRBANKS COMPANY

Valves, Dart Unions, Hand Trucks and Wheelbarrows

396 Lafayette St., New York, N. Y.

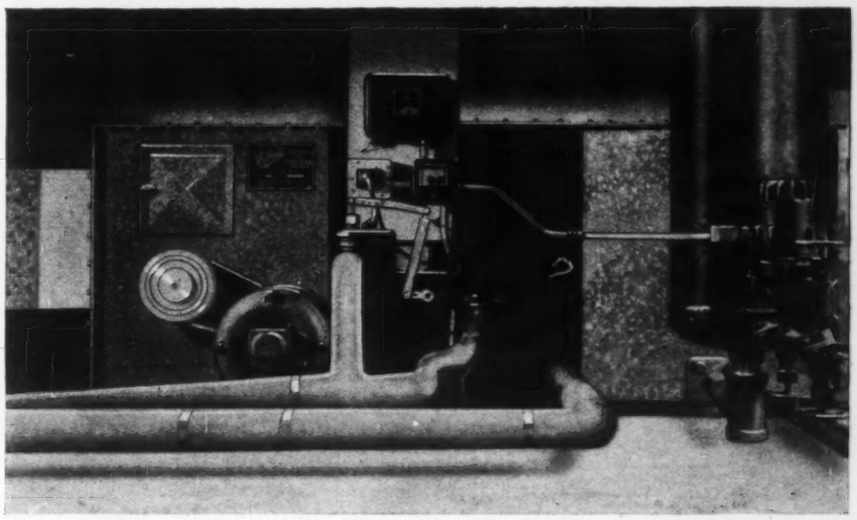
Boston • Pittsburgh • Distributors in Principal Cities

Factories: Binghamton, N. Y. • Rome, Ga.

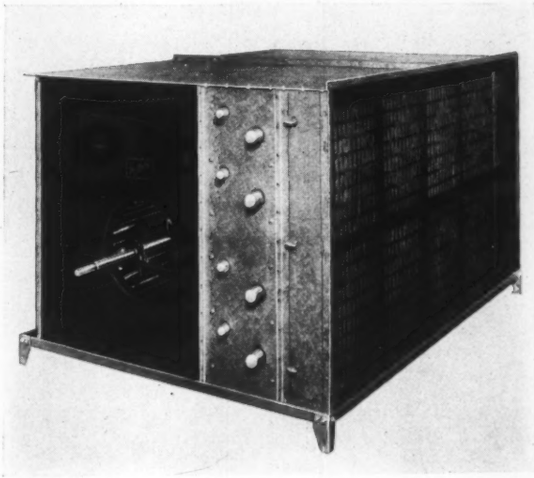
Fairbanks Renewable Valves

When You *Plan* Be Sure You *Get* —Ask Your Consulting Engineer *about* "Buffalo" P. C. UNITS

AIR CONDITIONING
AIR CONDITIONING



This "Buffalo" P. C. Cabinet does a complete air conditioning job.



"Buffalo" P. C. Cabinet built for 30 ton capacity. Note the few coil connections necessary.

These complete, compact units are built to do the *whole* job of air conditioning. Therefore, you can keep them busy the year 'round cooling and dehumidifying in summer; heating and humidifying in winter; cleaning the air at all times.

Furthermore, when you specify "Buffalo" equipment you automatically get the benefit of a long and wide experience in building equipment to solve air conditioning problems throughout the world.

So we repeat—"When you plan air conditioning be sure you get air conditioning." The safe way is to have "Buffalo" build your units to fit your exact needs.

Bulletin 501-B gladly mailed on request.

See our exhibit at the Fifth International Heating and Ventilating Exposition, Grand Central Palace, New York, January 24 to 28, 1938

BUFFALO FORGE COMPANY

171 MORTIMER ST. BUFFALO, N. Y.

Branch Engineering Offices in Principal Cities
In Canada: Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

in every community-

The HEATING & VENTILATING CONTRACTOR

can prepare to become the

Air Conditioning expert of tomorrow!

The same man to whom neighbors and friends come when they want to buy or install a heating system or to seek advice and assistance when they are experiencing difficulty with their present equipment.

MR. CONTRACTOR: When your customers want information on modern air conditioning — why not be prepared to properly advise them?

AUDITORIUM CONDITIONING CORPORATION has just completed a series of printed sheets describing some of its many AIR CONDITIONING SYSTEMS (*). Auditorium Systems are generally recognized as true air conditioning systems. These sheets are now in the hands of the capable engineers associated with the Branches, Distributors and Dealers of the Auditorium Licensees, listed below. These engineers, possessing a thorough knowledge and experience in air conditioning work, are competent to explain the systems described and to properly advise you regarding your problems. These advisors number thousands. There is one available within a short distance of the section in which you are located. Remember, ECONOMY IN OPERATION AND REASONABLE FIRST COST are outstanding features of ALL AUDITORIUM SYSTEMS—features that have recommended them for the most notable installations by leading air conditioning authorities.

The Auditorium Licensees listed below may give you permission to install Licensed Systems upon payment of a comparatively small fee. Get in touch with the one nearest you for any information desired.

WHETHER IT IS A CENTRAL STATION SYSTEM OR UNIT *SPECIFY AUDITORIUM*

(*) *Auditorium Air Conditioning Systems are covered by many issued patents and pending applications.*

AUDITORIUM LICENSEES

AMERICAN BLOWER CORPORATION
Detroit, Michigan

BUFFALO FORGE COMPANY
Buffalo, N. Y.

CARRIER CORPORATION
Syracuse, N. Y.

FRICK COMPANY
Waynesboro, Pa.

GENERAL ELECTRIC COMPANY
Schenectady, N. Y.

J. O. ROSS ENGINEERING CORPORATION
New York, N. Y.

THE COOLING & AIR CONDITIONING CORP.
(Division of B. F. Sturtevant Co.)
Hyde Park, Boston, Mass.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY
East Pittsburgh, Pa.

YORK ICE MACHINERY CORP.
York, Pa.

AUDITORIUM CONDITIONING CORPORATION

New York Office **17 EAST 42nd STREET, NEW YORK**

COME to EXPERTS

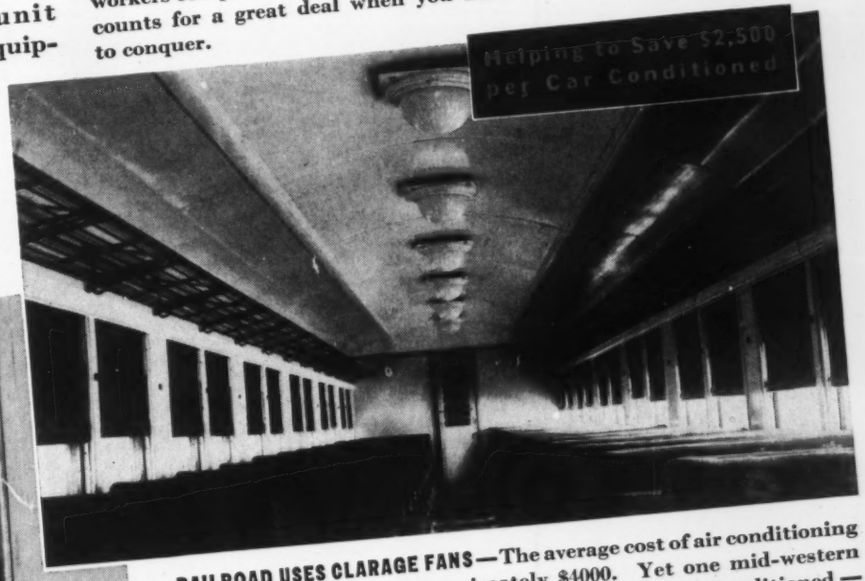
Every industry has developed leadership. Air handling and air conditioning is no exception.

When you have any type of "air" problem — in your factory, office, power plant, store, theatre or hotel — remember the name CLARAGE. This name ranks high in the air handling and conditioning field.

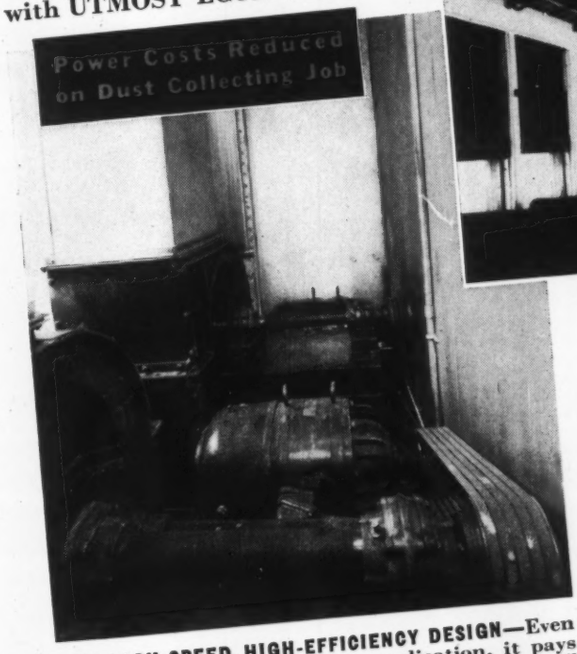
We manufacture fans, blowers, mechanical draft apparatus, unit heaters, coolers and conditioning equipment for every need — products seasoned by over a quarter-century of experience.

Your requirements entrusted to us are in EXPERT hands — and that always means RESULTS with UTMOST ECONOMY.

14,500 FEET OF WELDING ON 36 FANS—One certain process in a large chemical plant demands conditioned air almost microscopically clean. Clarage furnished the fans for this exacting job — 36 of them built of Monel metal to prevent corrosion. Photo above shows Clarage skilled workers completing one of the fan housings. Our 25 years' experience counts for a great deal when you have unusual service conditions to conquer.



RAILROAD USES CLARAGE FANS—The average cost of air conditioning a passenger coach is approximately $4000. Yet one mid-western railroad has reduced this cost to $1500 per coach conditioned — and results not sacrificed. Clarage Fan Units of special design play an important part in this economy program. Yes, savings of substantial proportion are often effected by adopting the recommendations of Clarage engineers.



NEW HIGH-SPEED, HIGH-EFFICIENCY DESIGN—Even on the simplest exhaust fan application, it pays to consult Clarage. The use of our new Type W Fan can make possible as high as a 25% reduction in size of motor required for drive — and invariably operating costs (power consumption) are below normal expectations.

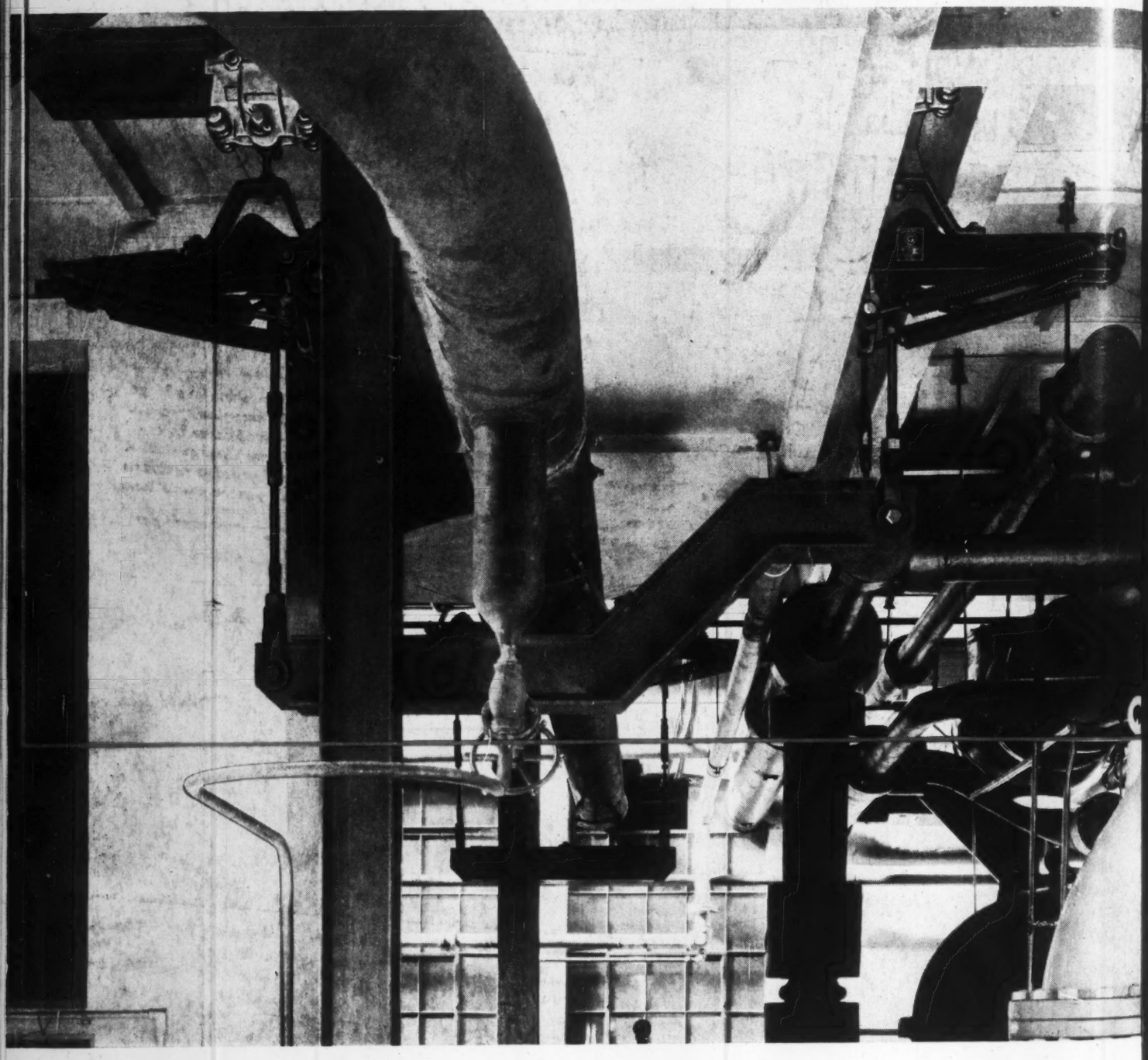
Nation-Wide Service

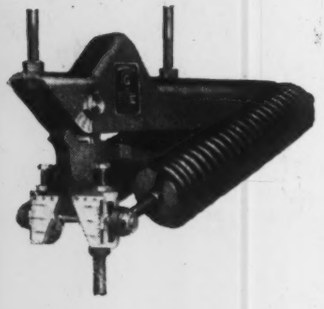
Why not give us a chance to present facts and figures? In every major industrial center, there is a Clarage sales-engineering office, manned by air handling and conditioning EXPERTS. Use your local telephone, or write us. We will carry through from then on—and promptly. No obligation, of course.

COMPLETE AIR CONDITIONING
•
COOLING
•
VENTILATION
•
FACTORY HEATING
•
MECHANICAL DRAFT
•
FANS and BLOWERS for INDUSTRIAL NEEDS

CLARAGE FAN COMPANY—KALAMAZOO, MICH.
SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES

"The Installation is as good as its Hangers"





No matter how much engineering genius is involved in the development of a prefabricated piping installation, that installation is only "as good as its hangers" — it must be free to float — to expand and contract in any direction. . . .

That is why the same engineering skill and experience that brought Grinnell Prefabrication into the lead built equal efficiency into Grinnell Genspring Constant Support Pipe Hanger. . . .

The Genspring Hanger affords constant, adequate support throughout the entire range of the pipe's vertical and horizontal movement. Thus it adds another reason to the many that prompt leading users of prefabricated piping to say "Give the plans to Grinnell!" Grinnell Company, Inc., Executive Offices, Providence, R. I. Branch offices in principal cities.

PREFABRICATION IN PICTU

Send for this booklet — you'll f
many worthwhile illustrations of c
plicated and routine power and pro
installations by
Grinnell.

PREFABRICATION AND FITTINGS BY GRINNELL

...WHENEVER PIPING IS INVOLVED...